FISHERIES REPORT

Warmwater Streams and Rivers

Tennessee Wildlife Resources Agency--Region IV

2009

FISHERIES REPORT
REPORT NO. 10-02
WARMWATER STREAM FISHERIES REPORT
REGION IV
2009

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TENNESSEE WILDLIFE RESOURCES AGENCY

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Cover: Rick Bivens displays a nuptial male River Redhorse *(Moxostoma carinatum)* collected in the French Broad River during 2009.

TABLE OF CONTENTS

INTRODUCTION

The fish fauna of Tennessee is the most diverse in the United States, with approximately 307 species of native fish and about 30 to 33 introduced species (Etnier and Starnes 1993). Region IV has 7,837 km of streams that total approximately 5,711 ha in 21 east Tennessee counties. There are approximately 1,287 km classified as coldwater streams. Streams in Region IV, except for a few in Anderson, Campbell, and Claiborne counties (Cumberland River System streams) are in the Ridge and Valley and Blue Ridge physiographic provinces of the upper Tennessee River drainage basin. The main river systems in the region are the Clinch, Powell, Little Tennessee, mainstream Tennessee River, French Broad, Nolichucky, and Holston.

Streams and rivers across the state are of considerable value as they provide a variety of recreational opportunities. These include fishing, canoeing, swimming, and other riverine activities that are unmatched by other aquatic environments. Streams and rivers are also utilized as water sources both commercially and domestically. The management and protection of this resource is recognized by Tennessee Wildlife Resources Agency (TWRA) and has been put forth in the Strategic Plan (TWRA 2006) as a primary goal.

This is the twenty-second annual report on stream fishery data collection in TWRA's Region IV. The main purpose of this project is to collect baseline information on game and non-game fish and macroinvertebrate populations in the region. This baseline data is necessary to update and expand our Tennessee Aquatic Database System (TADS) and aid in the management of fisheries resources in the region.

Efforts to survey the region’s streams have led to many cooperative efforts with other state and federal agencies. These have included the Tennessee Department of Environment and Conservation (TDEC), Tennessee Valley Authority (TVA), U.S. Forest Service (USFS), Oak Ridge National Laboratory (ORNL), and the National Park Service (NPS).

The information gathered for this project is presented in this report as river and stream accounts. These accounts include an introduction describing the general characteristics of the survey site, a study area and methods section summarizing site location and sampling procedures, a results section outlining the findings of the survey(s), and a discussion section, which allows us to summarize our field observations and make management recommendations.

METHODS

The streams to be sampled and the methods required are outlined in TWRA field request No. 04-09. Five rivers, three streams, and five wetland areas were sampled and are included in this report. Surveys were conducted from March to November 2009. A total of thirty (IBI, CPUE) fish, nine benthic macroinvertebrate, and six crayfish samples were collected.

SAMPLE SITE SELECTION

Index of Biotic Integrity (IBI) sample sites were selected that would give the broadest picture of impacts to the watershed. We typically located our sample site in close proximity to the mouth of a stream to maximize resident species collection. However, we positioned survey sites far enough upstream to decrease the probability of collecting transient species. Large river sampling sites were selected based on historical sampling locations and available access points. Typically we selected sample areas in these rivers that represented the best available habitat for any given reach being surveyed. Sampling locations were delineated in the field utilizing hand held Geographical Positioning Units (GPS) and then digitally re-created using a commercially available software package.

WATERSHED ANALYSIS

Watershed size and/or stream order has historically been used to create relationships for determining maximum expected species richness for IBI analysis. This has been accomplished by plotting species richness for a number of sites against watershed areas and/or stream orders (Fausch et al. 1984). We chose to use watershed area (kilometer^2) to develop our relationships as this variable has been shown to be a more reliable metric for predicting maximum species richness. Watershed areas (the area upstream of the survey site) were determined from USGS 1:24,000 scale maps.

FISH COLLECTIONS

A percentage of the fish data collected in this report was collected by employing an Index of Biological Integrity (Karr et al. 1986). Fish were collected with standard electrofishing (backpack) and seining techniques. A 5 x 1.3 meter seine was used to make hauls in shallow pool and run areas. Riffle and deeper run habitats were sampled with a seine in conjunction with a backpack electrofishing unit (100-600 VAC). An area approximately the length of the seine^2 (i.e., 5 meters x 5 meters) was electrofished in a downstream direction. A person with a dipnet assisted the person electrofishing in collecting those fish, which did not freely drift into the seine. Timed (5-min duration) backpack electrofishing runs were used to sample shoreline habitats. In both cases (seining or shocking) an estimate of area (meter^2) covered on each pass was calculated. Fish collections were made in all habitat types within the selected survey reach. Collections were made repeatedly for each habitat type until no new species was collected for three consecutive samples for each habitat type. All fish collected from each sample were enumerated. Anomalies (e.g., parasites, deformities, eroded fins, lesions, or tumors) were noted along with occurrences of hybridization. After processing, the captured fish were either held in captivity or released into the stream where they could not be recaptured. In larger rivers, a boat was used in conjunction with the backpack samples to effectively sample deep pool habitat. Timed (10-min duration) runs were used until all habitat types had been depleted.

Catch-per-unit-effort samples (CPUE) were conducted in three rivers during 2009. Timed boat electrofishing runs were made in pool and shallower habitat where navigable. Efforts were made to sample the highest quality habitat in each sample site and include representation of all habitat types typical to the reaches surveyed. Total electrofishing time was calculated and used to determine our catch-effort estimates (fish/hour).

Generally, fish were identified in the field and released. Problematic specimens were preserved in 10% formalin and later identified in the lab or taken to Dr. David A. Etnier at the University of Tennessee Knoxville (UTK) for identification. Most of the preserved fish collected in the 2009 samples will be catalogued into our reference collection or deposited in the University of Tennessee Research Collection of Fishes. Common and scientific names of fishes used in this report are after Nelson et al. (2004), Powers and Mayden (2007) and Etnier and Starnes (1993).

BENTHIC COLLECTIONS

Qualitative benthic samples were collected from each IBI fish sample site and at four other locations for a total of nine samples. These were taken with aquatic insect nets, by rock turning, and by selected pickings from as many types of habitat as possible within the sample area. Taxa richness and relative abundance are the primary considerations of this type of sampling. Taxa richness reflects the health of the benthic community and biological impairment is reflected in the absence of pollution sensitive taxa such as Ephemeroptera, Plecoptera, and Trichoptera (EPT).

Large particles and debris were picked from the samples and discarded in the field. The remaining sample was preserved in 70% ethanol and later sorted in the laboratory. Organisms were enumerated and attempts were made to identify specimens to species level when possible. Many were identified to genus, and most were at least identified to family. Dr. David A. Etnier (UTK) examined problematic specimens and either made the determination or confirmed our identifications. Comparisons with identified specimens in our aquatic invertebrate collection were also useful in making determinations. For the most part, nomenclature of aquatic insects used in this report follows Brigham et al. (1982) and Louton (1982). Names of stoneflies (Plecoptera) are after Stewart and Stark (1988) and caddisflies are after Etnier et al. (1998). Benthic results are presented in tabular form with each stream account.

WATER QUALITY MEASUREMENTS

Basic water quality data were taken at most sites in conjunction with the fishery and benthic samples. The samples included temperature, pH, and conductivity. Data were taken from midstream and mid-depth at each site, using a YSI model 33 S-C-T meter. Scientific Products™ pH indicator strips were used to measure pH. Stream velocities were measured with a Marsh-McBirney Model 201D current meter. The Robins-Crawford "rapid crude" technique (as described by Orth 1983) was used to estimate flows. Water quality parameters were recorded and are included with each stream account.

HABITAT QUALITY ANALYSIS

Beginning in 2004, the stream survey unit introduced an experimental habitat assessment form that built on the existing method by incorporating biological impairment and metric modifications to the standardized form (Smith et al. 2002). The major advantages of this evaluation procedure include more concise metrics and categories that identify the stream or river based on size, gradient, temperature, ecoregion and alterations of flow based on groundwater or hydroelectric influences.

The other issue we wanted to address with this new evaluation was the development of our own biotic index for benthic macroinvertebrates. By assigning an overall value to the water quality, habitat, and biological impairment of a given reach of stream we can begin to assign tolerance values to associated benthic insect species collected during the survey. This will ultimately allow us to develop a more accurate biotic index for benthic macroinvertebrates for the Ridge and Valley and Blue Ridge Ecoregions of east Tennessee. The illustrations on the following page depict the layout of the experimental form including the 14 habitat/water quality metrics, the biotic index adjustment, ecoregion classification, and stream type.

We feel that this form allows us to be more precise in our evaluation of the stream habitat quality and gives us a more defined evaluation pertaining to stream morphology and location. We will continue to complete both habitat evaluations for each stream survey for the next couple of field seasons in order to fully evaluate the new form.

Experimental Stream Habitat Assessment Form

STREAM QUALITY ASSESSMENT FORM

FORM:SQA-09-2004

Tennessee Wildlife Resources Agency Stream Survey Unit

STREAM:______________________ DATE:______________________

INVESTIGATOR:______________________ SITE CODE:______________________

LAT/LONG:______________________ ELEVATION:______________________

Rate Each Of The Following 14 Metrics:
0(EXCELLENT) 1(GOOD) 2(FAIR) 3(POOR) 4(VERY POOR)
note: 0 = pristine condition and 4 = worst condition

SCORE

1 SILTATION ☐
(fine particles that blanket [smother] the substrate)

2 SUBSTRATE EMBEDDEDNESS ☐
(interstitial spaces between gravel, cobble and boulder have become filled with fine deposits such as sand making the underside habitat unsuitable to aquatic life)

3 BED-LOAD MOVEMENT ☐
(condition pertaining to excessive bed load movement, and frequent formation and destruction of sand and gravel bars)

4 STATE OF SMALL RIPARIAN VEGETATION ☐
(grasses, shrubs, etc. that stabilize the soil surface and serve as runoff filters)

5 STATE OF LARGE RIPARIAN VEGETATION ☐
(canopy trees that provide long-term bank stability and shade)

6 BANK STABILITY ☐
(signs of bank erosion)

7 PHYSICAL DAMAGE TO STREAM HABITAT BY DOMESTIC LIVESTOCK ☐
(obvious signs of damage within riparian zone and instream habitat from livestock traffic)

8 ALTERATIONS OF NATURAL PHYSICAL CHARACTERS OF STREAMBED ☐
(channelization, gravel dredging, channel relocation, bridges, culverts, dams, fords etc.)

9 TURBIDITY ☐
(suspended solids "muddy or cloudy")

10 POINT SOURCE POLLUTION ☐
(FACTORY, MINING SOURCE, etc.)
(pipes or ditches conveying contaminated effluent adversely affecting water quality), chemical odor and/or unusual water or substrate coloration. (reddish algae [organic] or iron oxide [inorganic] often associated with severe earth disturbance)

11 ENRICHMENT ☐
(agricultural livestock waste and/or crop fertilizers, poorly functioning municipal waste water treatment facility or residential septic systems often indicated by filamentous algae etc.)

12 ATYPICAL WATER QUALITY PARAMETERS (BASIC) ☐
(unusually high or low pH, conductivity, dissolved oxygen, or temperature)

13 ENVIRONMENTALLY HARMFUL TRASH ☐
(human refuse including oil filters, engines, batteries, tires, etc. that may be toxic to aquatic organisms)

14 ALTERED STREAM FLOW (CFS) ☐
(abnormal fluctuations in flow volume [e.g. hydroelectric dam regulation], or low flow due to water consumption for municipal water, bottled water, crop irrigation, or other water demands.)

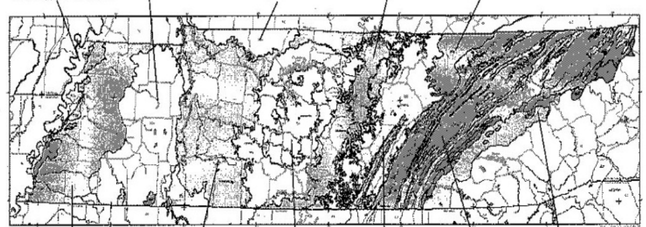
TOTAL ☐

BIOTIC INDEX ADJUSTMENT (BIA) + ☐
(does one or more of the previous 14 metrics seriously inhibit aquatic life?)
0 (no biological impairment) **5** (only the most sensitive taxa impaired)
10 (somewhat diverse but most intolerant forms absent) **15** (low diversity—tolerant forms only)
20 (little or no aquatic life present)

STREAM ASSESSMENT VALUE = TOTAL + BIA → ☐

0 - 10 (EXCELLENT) 11 - 21 (GOOD) 22 - 32 (FAIR) 33 - 43 (POOR) $\geq$44 (VERY POOR)

INDICATE (CIRCLE) ECOREGION:



STREAM TYPE:	GRADIENT LOW	GRADIENT MOD	GRADIENT HIGH	TEMPERATURE COLD	TEMPERATURE COOL	TEMPERATURE WARM	
	<0.01	0.01-0.05	>0.05	<20°C	<25°C	>25°C	Maximum Summer Temp
HEADWATER (0 - 2 METERS)	☐	☐	☐	☐	☐	☐	
SMALL CREEK (2.1 -11.0 METERS)	☐	☐	☐	☐	☐	☐	
LARGE CREEK (11.1 -21.0 METERS)	☐	☐	☐	☐	☐	☐	
SMALL RIVER 1 (21.1 - 111 METERS)	☐	☐	☐	☐	☐	☐	
SMALL RIVER 2 (111.1 - 201 METERS)	☐	☐	☐	☐	☐	☐	
MEDIUM RIVER (202 METERS - 502 METERS)	☐	☐	☐	☐	☐	☐	
LARGE RIVER (>503 METERS)	☐	☐	☐	☐	☐	☐	

CHECK IF STREAM IS:

A SPRING RUN (near source) ☐
A CREEK WITH SIGNIFICANT SPRING INFLUENCE ☐
A TAILWATER ☐

Ecoregion designations follow Griffith (USEPA) et al. Stream Type, and Gradient definitions generally follow Smith, R.K., P.L. Freeman, J.V. Higgins, K.S. Wheaton, T.W. FitzHugh, K.J. Ernstrom, A.A. Das. Priority Areas for Freshwater Conservation: A Biodiversity of the Southeastern United States. The Nature Conservancy. 2002.

DATA ANALYSIS

Twelve metrics described by Karr et al. (1986) were used to determine an IBI score for each stream surveyed. These metrics were designed to reflect fish community health from a variety of perspectives (Karr et al. 1986). Given that IBI metrics were developed for the midwestern United States, many state and federal agencies have modified the original twelve metrics to accommodate regional differences. Such modifications have been developed for Tennessee primarily through the efforts of TWRA (Bivens et al. 1995), TVA, and Tennessee Tech University. In developing our scoring criteria for the twelve metrics we reviewed pertinent literature [North American Atlas of Fishes (Lee et al. 1980), The Fishes of Tennessee (Etnier and Starnes 1993), various TWRA Annual Reports and unpublished data] to establish historical and more recent accounts of fishes expected to occur in the drainages we sampled. Scoring criteria for the twelve metrics were modified according to watershed size. Watersheds draining less than 13 kilometer^2 were assigned different scoring criteria than those draining greater areas. This was done to accommodate the inherent problems associated with small stream samples (e.g., lower catch rates and species richness). Young-of-the-year fish and non-native species were excluded from the IBI calculations. After calculating a final score, an integrity class was assigned to the stream reach based on that score. The classes used follow those described by Karr et al. (1986).

Karr et al. (1986) criteria

Total IBI score (sum of the 12 metric ratings)	Integrity Class	Attributes
58-60	Excellent	Comparable to the best situations without human disturbance; all regionally expected species for the habitat and stream size, including the most intolerant forms, are present with a full array of size classes; balanced trophic structure.
48-52	Good	Species richness somewhat below expectation, especially due to the loss of the most intolerant forms; some species are present with less than optimal abundance or size distributions; trophic structure

		shows some signs of stress.
40-44	Fair	Signs of additional deterioration include loss of intolerant forms, fewer species, highly skewed trophic structure (e.g., increasing frequency of omnivores and green sunfish or other tolerant species); older age classes of top predators may be rare.
28-34	Poor	Dominated by omnivores, tolerant forms, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; hybrids and diseased fish often present.
12-22	Very poor	Few fish present, mostly introduced or tolerant forms; hybrids common; disease, parasites fin damage, and other anomalies regular.
	No fish	Repeated sampling finds no fish.

Catch-per-unit-effort analysis was performed for three large rivers sampled during 2009. Total time spent electrofishing at each site was used to calculate the CPUE estimates for each species collected. Length categorization analysis (Gabelhouse 1984) was used to calculate Proportional Stock Density (PSD) and Relative Stock Density (RSD) for black bass and rock bass populations sampled.

Benthic data collected for the 2009 surveys were subjected to a biotic index that rates stream condition based on the overall taxa tolerance values and the number of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa present. The North Carolina Division of Environmental Management (NCDEM) has developed a bioclassification index and associated criteria for the southeastern United States (Lenat 1993). This technique rates water quality according to scores derived from taxa tolerance values and EPT taxa richness values. The final derivation of the water quality classification is based on the combination of scores generated from the two indices. The criteria used to generate the biotic index values and EPT values are as follows:

Score	Biotic Index Values	EPT Values
5 (Excellent)	< 5.14	> 33
4.6	5.14-5.18	32-33
4.4	5.19-5.23	30-31
4 (Good)	5.24-5.73	26-29
3.6	5.74-5.78	24-25
3.4	5.79-5.83	22-23
3	5.84-6.43	18-21
2.6	6.44-6.48	16-17
2.4	6.49-6.53	14-15
2	6.54-7.43	10-13
1.6	7.44-7.48	8-9
1.4	7.49-7.53	6-7
1 (Poor)	> 7.53	0-5

The overall result is an index of water quality that is designed to give a general state of pollution regardless of the source (Lenat 1993). Taxa tolerance rankings were based on those given by NCDEM (1995) with minor modifications for taxa, which did not have assigned tolerance values.

Little River

Introduction

Little River originates in Sevier County on the north slope of Clingmans Dome, in the Great Smoky Mountains National Park. It flows in a northwesterly direction for about 95 kilometers, past Elkmont in the National Park, and

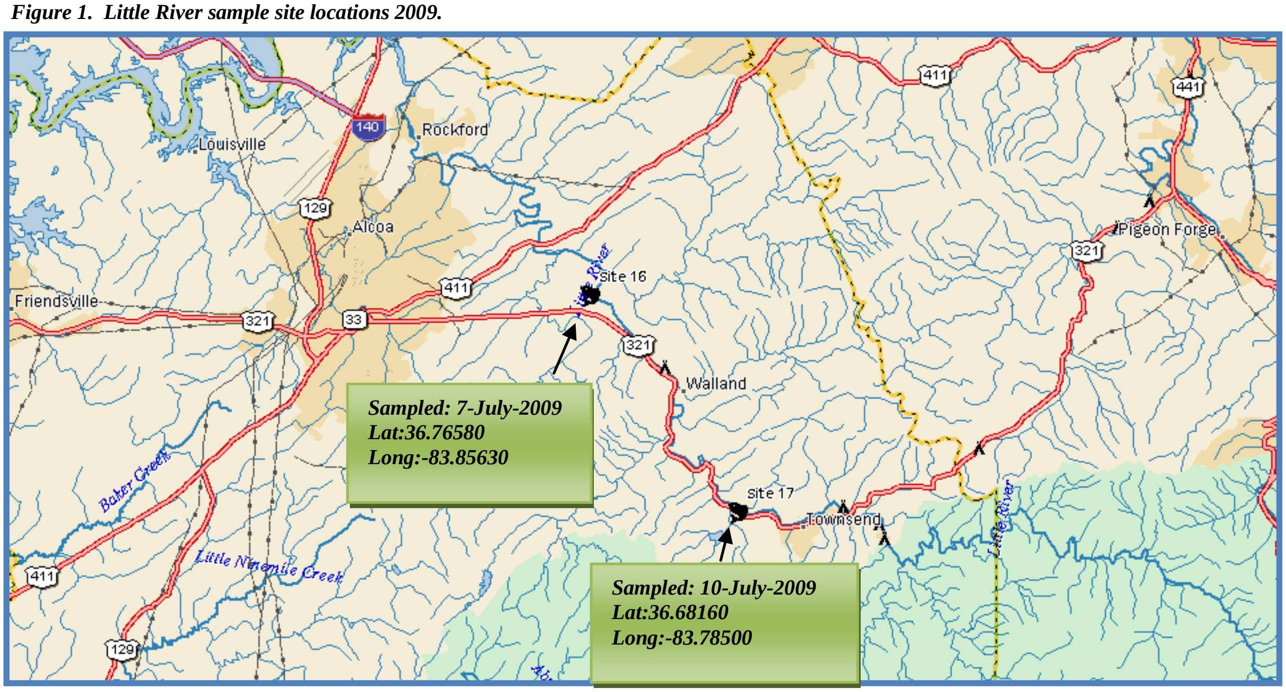
Townsend, Walland, and Maryville in Blount County, and joins the Tennessee River near river mile 635.6. Fort Loudoun Reservoir, impounds the lower 6.8 miles of Little River with another 1.5 miles being impounded by the low head dam at Rockford (located at the backwaters of Fort Loudoun). In all, a little over eight river miles are impounded. Another 0.75 mile or so is impounded by Perrys Milldam downstream of Walland, near river mile 22. A third low head dam is located in Townsend near river mile 33.6. The river has a drainage area of approximately 982 km^2 at its confluence with the Tennessee River. The upper reach of the river (upstream of Walland) is located in the Blue Ridge physiographic province, and then transitions into the Ridge and Valley province from Walland to Fort Loudoun Reservoir. Little River is a very scenic stream in the Great Smoky Mountains National Park. There, it drains an area containing some of the most spectacular scenery in the southeastern United States. The Little River fishery within the National Park boundary is primarily wild rainbow and brown trout with smallmouth bass in the lower reaches. An excellent trout fishery exists, and is managed by the National Park Service. Little River's gradient becomes moderate as it leaves the National Park and flows through the Tuckaleechee Valley from Townsend to Walland. Excellent populations of smallmouth bass and rock bass exist there, and rainbow trout are stocked in spring and fall as water temperatures allow. This portion of the river has many developed campgrounds and is a popular recreation destination for tourists. While not as developed as Pigeon Forge, the Townsend area has grown significantly over the past two decades. Downstream of Walland, Little River leaves the mountains and no longer displays the extreme clarity and attractive rocky bottom of its upper reaches. Here it enters the Ridge and Valley province and resembles the more typical large river habitat with lower gradient and large deep pools interspersed with shallow shoal areas. Downstream of Perrys Milldam, the fishery, while still primarily smallmouth bass and rock bass, declines in quality relative to the upstream reach. This is probably related to limited availability of preferred smallmouth bass habitat. Near the small community of Rockford, Little River flows into a surprisingly large (given the size of the stream) embayment of Fort Loudon Lake. The Little River forms the boundary between Blount County and Knox County for the last few miles of its course.

Little River represents an important recreational resource for the state both in consumptive and non-consumptive uses. It supports an active tubing/rafting industry and is an important recreational resource for local residents and tourists alike. It is also the municipal water source of the cities of Alcoa and Maryville. It provides critical habitat for species of special concern and is home to over 50 species of fish (four listed federally). Additionally, its upper reach supports one of east Tennessee's better warm water sport fisheries. It provides anglers with the opportunity to catch all species of black bass, rock bass, and even stocked rainbow trout when water temperatures allow.

Study Area and Methods

Our 2009 survey of Little River consisted of two IBI sites (Coulters Bridge and Townsend). We cooperated with several agencies in conducting the two IBI samples between July 7 and 10. The Coulters Bridge site (16) is located in the Ridge and Valley Province of Blount County while the Townsend site (17) lies in the transitional zone between the Blue Ridge and the Ridge and Valley Provinces (Figure1).

Figure 1. Little River sample site locations 2009.



Public access along the river is primarily limited to bridge crossings and small "pull-outs" along roads paralleling the river. There are several primitive launching areas for canoes or small boats and one developed access area managed by the Agency (Perrys Mill).

Results

Collaborative community assessments of Little River have been ongoing since the 1980's. These surveys have primarily focused on evaluating relative health changes in the fish community. Two Index of Biotic Integrity surveys were conducted in July 2009, one at Coulters Bridge (river mile 20) and one at Townsend (river mile 29.8). A total of 50 fish species were collected at the Coulters Bridge site while 32 were observed at Townsend. Overall, the IBI analysis indicated the fish community was in excellent condition at Coulters Bridge (IBI score 58). The condition of the fish community improved slightly (2 points, score 58) at the upper station, Townsend, when compared to the 2008 score (Figure 2). Several rare or endangered species of fish inhabit Little River, and thus, the protection of the watershed is a high priority of managing agencies and local conservation groups. Table 1 lists the species and number of fish collected at the two IBI stations.

Figure 2. Trends in the Index of Biotic Integrity (IBI) at two stations in Little River (1987-2009).

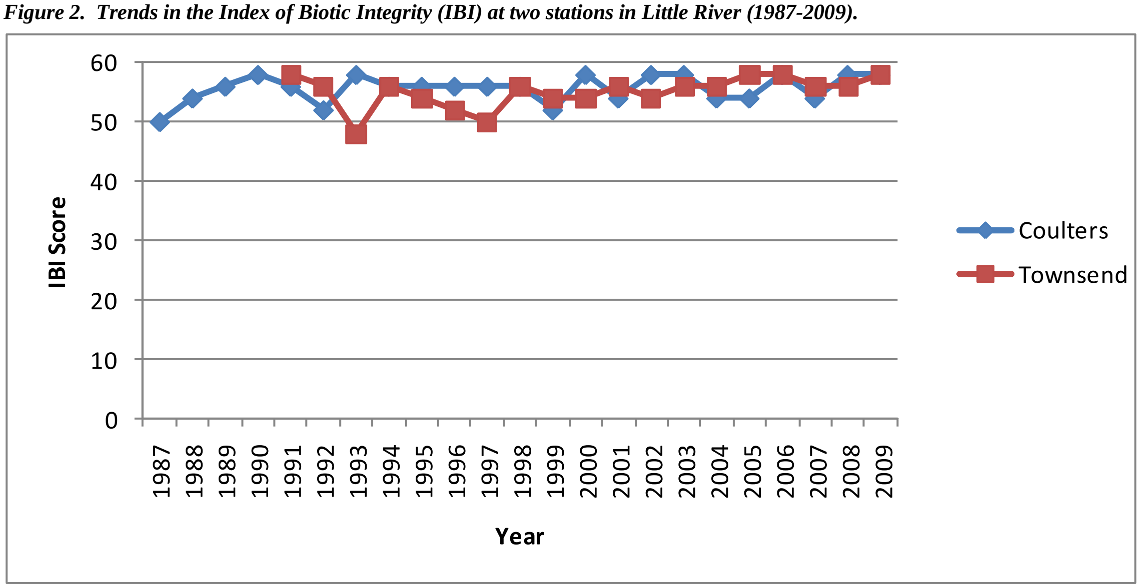


Table 1. Fish species collected at two Little River IBI stations 2009.

Site	Species	Number Collected
420091716 (Coulters Bridge)	*Ambloplites rupestris*	47
420091716 (Coulters Bridge)	*Ameiurus natalis*	2
420091716 (Coulters Bridge)	*Aplodinotus grunniens*	2
420091716 (Coulters Bridge)	*Campostoma oligolepis*	73
420091716 (Coulters Bridge)	*Cottus carolinae*	20
420091716 (Coulters Bridge)	*Cyprinella galactura*	43
420091716 (Coulters Bridge)	*Cyprinella spiloptera*	16
420091716 (Coulters Bridge)	*Cyprinus carpio*	4
420091716 (Coulters Bridge)	*Dorosoma cepedianum*	18
420091716 (Coulters Bridge)	*Erimystax insignis*	21
420091716 (Coulters Bridge)	*Etheostoma blennioides*	37
420091716 (Coulters Bridge)	*Etheostoma camurum*	7
420091716 (Coulters Bridge)	*Etheostoma jessiae*	7
420091716 (Coulters Bridge)	*Etheostoma rufilineatum*	917
420091716 (Coulters Bridge)	*Etheostoma tenneseense*	6
420091716 (Coulters Bridge)	*Etheostoma zonale*	23
420091716 (Coulters Bridge)	*Fundulus catenatus*	2
420091716 (Coulters Bridge)	*Hybopsis amblops*	17
420091716 (Coulters Bridge)	*Hypentelium nigricans*	25
420091716 (Coulters Bridge)	*Ichthyomyzon castaneus*	4
420091716 (Coulters Bridge)	*Ictalurus punctatus*	2
420091716 (Coulters Bridge)	*Labidesthes sicculus*	1
420091716 (Coulters Bridge)	*Lepisosteus osseus*	3
420091716 (Coulters Bridge)	*Lepomis auritus*	102
420091716 (Coulters Bridge)	*Lepomis cyanellus*	1
420091716 (Coulters Bridge)	*Lepomis macrochirus*	36
420091716 (Coulters Bridge)	*Lepomis microlophus*	3
420091716 (Coulters Bridge)	*Luxilus chrysocephalus*	14
420091716 (Coulters Bridge)	*Luxilus coccogenis*	7
420091716 (Coulters Bridge)	*Lythrurus lirus*	47
420091716 (Coulters Bridge)	*Micropterus dolomieu*	10
420091716 (Coulters Bridge)	*Micropterus punctulatus*	3
420091716 (Coulters Bridge)	*Micropterus salmoides*	3
420091716 (Coulters Bridge)	*Minytrema melanops*	5
420091716 (Coulters Bridge)	*Moxostoma anisurum*	1
420091716 (Coulters Bridge)	*Moxostoma carinatum*	23
420091716 (Coulters Bridge)	*Moxostoma duquesneii*	108
420091716 (Coulters Bridge)	*Moxostoma erythrurum*	53
420091716 (Coulters Bridge)	*Nocomis micropogon*	24
420091716 (Coulters Bridge)	*Notropis leuciodus*	31
420091716 (Coulters Bridge)	*Notropis micropteryx*	69
420091716 (Coulters Bridge)	*Notropis photogenis*	16
420091716 (Coulters Bridge)	*Notropis telescopes*	20
420091716 (Coulters Bridge)	*Notropis volucellus*	10
420091716 (Coulters Bridge)	*Noturus eleutherus*	16
420091716 (Coulters Bridge)	*Percina aurantiaca*	1
420091716 (Coulters Bridge)	*Percina burtoni*	1
420091716 (Coulters Bridge)	*Percina evides*	13
420091716 (Coulters Bridge)	*Percina williamsi*	2
420091716 (Coulters Bridge)	*Phenacobius uranops*	5
420091717 (Townsend)	*Ambloplites rupestris*	47
420091717 (Townsend)	*Campostoma anomalum*	12
420091717 (Townsend)	*Catostomus commersonii*	5
420091717 (Townsend)	*Cottus carolinae*	31
420091717 (Townsend)	*Cyprinella galactura*	203
420091717 (Townsend)	*Erimystax insignis*	4

Table 1. Continued.

Site	Species	Number Collected
420091717 (Townsend)	*Etheostoma blennioides*	17
420091717 (Townsend)	*Etheostoma rufilineatum*	190
420091717 (Townsend)	*Etheostoma tennesseense*	8
420091717 (Townsend)	*Etheostoma zonale*	13
420091717 (Townsend)	*Fundulus catenatus*	11
420091717 (Townsend)	*Hybopsis amblops*	12
420091717 (Townsend)	*Hypentelium nigricans*	28
420091717 (Townsend)	*Ichthyomyzon greeleyi*	14
420091717 (Townsend)	*Lampetra appendix*	7
420091717 (Townsend)	*Lepomis auritus*	1
420091717 (Townsend)	*Lepomis cyanellus*	1
420091717 (Townsend)	*Lepomis macrochirus*	6
420091717 (Townsend)	*Luxilus chrysocephalus*	3
420091717 (Townsend)	*Luxilus coccogenis*	61
420091717 (Townsend)	*Lythrurus lirus*	79
420091717 (Townsend)	*Micropterus dolomieu*	18
420091717 (Townsend)	*Micropterus salmoides*	1
420091717 (Townsend)	*Moxostoma duquesneii*	22
420091717 (Townsend)	*Nocomis micropogon*	9
420091717 (Townsend)	*Notropis leuciodus*	101
420091717 (Townsend)	*Notropis micropteryx*	9
420091717 (Townsend)	*Notropis photogenis*	15
420091717 (Townsend)	*Notropis telescopus*	252
420091717 (Townsend)	*Notropis volucellus*	4
420091717 (Townsend)	*Percina burtoni*	1
420091717 (Townsend)	*Percina evides*	1

Benthic macroinvertebrates collected in our sample at Townsend comprised 35 families representing 48 identified genera (Table 2). The most abundant group in our collection was the mayflies comprising 24.1% of the total sample. Overall, a total of 61 taxa were identified from the sample of which 28 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "Good" (4.5).

Table 2. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Little River at Townsend during 2009.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				1.22
	Oligochaeta		4	
COLEOPTERA				11.62
	Dryopidae	*Helichus* adults	2	
	Elmidae	*Dubiraphia* adults	3	
		Macronychus glabratus larvae and adults	9	
		Optioservus trivittatus adults	3	
		Promoresia elegans larvae and adults	8	
		Promoresia tardella adults	1	
	Gyrinidae	*Gyrinus* larvae	2	
	Psephenidae	*Psephenus herricki*	10	
DECAPODA				0.61
	Cambaridae	*Orconectes erichsonianus*	1	
		Orconectes forceps	1	
DIPTERA				10.70
	Athericidae	*Atherix lantha*	1	
	Chironomidae		22	
	Simuliidae		11	
	Tipulidae	*Antocha*	1	
EPHEMEROPTERA				24.16
	Baetidae	*Baetis*	12	
		Procloeon	2	
	Ephemerellidae	*Eurylophella*	8	
		Serratella	3	

Table 2. Continued.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
	Ephemeridae	*Hexagenia*	1	
	Heptageniidae	*Heptagenia*	4	
		Leucrocuta	11	
		Maccaffertium early instars	9	
		Maccaffertium ithaca	4	
		Maccaffertium mediopunctatum	3	
		Stenacron interpunctatum	4	
	Isonychiidae	*Isonychia*	11	
	Leptohyphidae	*Tricorythodes*	7	
GASTROPODA				11.01
	Pleuroceridae	*Leptoxis*	7	
		Pleurocera	29	
HETEROPTERA				0.92
	Nepidae	*Ranatra nigra* adult	1	
	Veliidae	*Rhagovelia obesa* adults	2	
HYDRACARINA			5	1.53
ISOPODA				0.31
	Asellidae	*Caecidotea*	1	
MEGALOPTERA				4.59
	Corydalidae	*Corydalus cornutus*	8	
		Nigronia serricornis	7	
ODONATA				11.93
	Aeshnidae	*Boyeria vinosa*	9	
	Coenagrionidae	*Argia*	4	
	Cordulegastridae	*Cordulegaster maculata*	1	
	Gomphidae	*Gomphurus rogersi*	2	
		Gomphus lividus	7	
		Hagenius brevistylus	4	
		Hylogomphus brevis	1	
		Lanthus vernalis	8	
	Macromiidae	*Macromia*	3	
PELECYPODA				1.22
	Corbiculidae	*Corbicula fluminea*	4	
PLECOPTERA				8.26
	Leuctridae	*Leuctra*	5	
	Peltoperlidae	*Peltoperla*	1	
	Perlidae	*Perlesta* freckled form	1	
		Perlesta non-freckled form	15	
	Pteronarcyidae	*Pteronarcys dorsata*	5	
TRICHOPTERA				11.93
	Brachycentridae	*Brachycentrus lateralis*	11	
	Hydropsychidae	*Ceratopsyche morosa*	2	
		Ceratopsyche sparna	1	
		Cheumatopsyche	7	
		Hydropsyche venularis	4	
	Leptoceridae	*Oecetis avara*	1	
		Triaenodes ignitus	4	
		Triaenodes perna	1	
	Limnephilidae	*Pycnopsyche gentilis*	1	
		Pycnopsyche guttifer	4	
		Pycnopsyche luculenta group	3	
			4	
		Total	327	

TAXA RICHNESS = 61 EPT TAXA RICHNESS = 28 BIOCLASSIFICATION = GOOD (4.5)

Benthic macroinvertebrates collected in our sample at Coulters Bridge comprised 38 families representing 50 identified genera (Table 3). The most abundant group in our collection was the mayflies comprising 29.1% of the total sample. Overall, a total of 61 taxa were identified from the sample of which 24 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "Good" (4.3).

Table 3. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Little River at Coulters Bridge during 2009 .

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				3.95
	Oligochaeta		14	
COLEOPTERA				16.38
	Dryopidae	*Helichus* adults	5	
	Elmidae	*Dubiraphia* adults	2	
		Macronychus glabratus adults	4	
		Optioservus larva	1	
		Optioservus trivittatus adults	23	
		Promoresia elegans adults	6	
	Gyrinidae	*Dineutus* adults and larvae	4	
		Gyrinus larva and adult	2	
	Hydrophilidae	*Laccobius* adult	1	
		Tropisternus natator adult	1	
	Psephenidae	*Psephenus herricki* larvae and adults	9	
DECAPODA				2.26
	Cambaridae	*Orconectes* sp. juveniles only	8	
DIPTERA				3.67
	Chironomidae		8	
	Simuliidae		3	
	Tipulidae	*Antocha*	1	
		Tipula	1	
EPHEMEROPTERA				29.10
	Baetidae	*Acentrella*	1	
		Baetis	29	
	Ephemerellidae	*Eurylophella*	6	
		Serratella	2	
	Heptageniidae	*Epeorus rubidus/subpallidus*	11	
		Maccaffertium early instars	25	
		Maccaffertium ithaca	1	
		Maccaffertium mediopunctatum	2	
		Rithrogena	1	
	Isonychiidae	*Isonychia*	20	
	Leptohyphidae	*Tricorythodes*	5	
GASTROPODA				6.21
	Ancylidae	*Ferrissia*	1	
	Physidae		1	
	Pleuroceridae	*Leptoxis*	15	
		Pleurocera	5	
HETEROPTERA				2.26
	Corixidae adult		1	
	Gerridae	*Metrobates hesperius* nymph	1	
	Nepidae	*Ranatra kirkaldyi*	3	
		Ranatra nymphs	2	
	Veliidae	*Rhagovelia obesa*	1	
MEGALOPTERA				1.98
	Corydalidae	*Corydalus cornutus*	5	
		Nigronia serricornis	2	
ODONATA				8.76
	Aeshnidae	*Boyeria vinosa*	10	
	Calopterygidae	*Hetaerina americana*	2	
	Coenagrionidae	*Argia*	3	
		Enallagma	4	
	Gomphidae	*Dromogomphus spinosus*	2	
		Gomphurus lineatifrons	1	
		Hagenius brevistylus	2	
		Stylogomphus albistylus	1	
	Macromiidae	*Macromia*	6	
PELECYPODA				2.54
	Corbiculidae	*Corbicula fluminea*	8	
	Unionidae		1	
PLECOPTERA				6.21
	Peltoperlidae	*Peltoperla*	2	
	Perlidae	*Acroneuria* early instar	1	
		Perlesta freckled form	13	
		Perlesta non-freckled form	6	
TRICHOPTERA				16.67
	Brachycentridae	*Brachycentrus lateralis*	3	
		Ceratopsyche morosa	16	
		Cheumatopsyche	22	
		Hydropsyche venularis	2	
	Hydropsychidae pupa		1	
	Leptoceridae	*Triaenodes ignitus*	5	
		Triaenodes injustus	2	
	Limnephilidae	*Pycnopsyche guttifer/scabripennis* groups	1	
		Pycnopsyche lepida group	1	
	Philopotamidae	*Chimara*	3	
	Polycentropodidae	*Polycentropus*	3	
		Cheumatopsyche	22	
		Total	354	

TAXA RICHNESS = 61 EPT TAXA RICHNESS = 24 BIOCLASSIFICATION = GOOD (4.3)

Discussion

Little River provides anglers with the opportunity to catch all species of black bass along with rock bass. Because of the low numbers of spotted and largemouth bass in Little River, it should not be considered a viable sport fishery for these species.

The river represents an outstanding resource in the quality of the water and the species that inhabit it. With the growing development in the watershed it will be imperative to monitor activities such that mitigation measures can be taken to ensure that the river maintains its outstanding water quality and aesthetic value. Continued efforts by the watershed group will play an important role in the management of the watershed and serve as a “watchdog” for unregulated activities.

Trout stocking during suitable months is very popular for residents and non-residents visiting the area. This program should continue at the current level unless use dictates the need for program expansion.

TWRA should continue to be involved with the cooperative community assessment surveys each year. These are important indicators of the health of one of the region’s best streams and serves as a benchmark in evaluating other streams of similar size and character. Effective March 1, 2009, smallmouth bass regulations in Little River from Rockford Dam upstream to the Great Smoky Mountains National Park boundary will protect bass 13 to 17 inches in length. One fish of the five fish daily creel limit can exceed 17 inches. Sport fishery surveys on Little River will be conducted on a three-year rotation in order to assess any changes in the fishery. Our return trip in 2011 to look at the sport fish will in all likelihood focus on the sample sites surveyed in 2008, providing no new or more efficient sampling scheme is developed.

Management Recommendations

1. Initiate an angler use and harvest survey.

2. Develop a fishery management plan for the river.

3. Cooperate with the local watershed organization to protect and enhance the river and its tributaries.

Holston River

Introduction

The Holston River represents a valuable recreational resource to the state as it provides water based recreation to several communities, towns, and cities along its course. It is also an important source of drinking water for many populations between Kingsport and Knoxville. Historically, the Holston River has been subjected to many man-induced alterations including channelization, damming, and pollution. Two dams regulate most of the flow outside of tributaries that enter the river above and below these dams. Fort Patrick Henry Dam located on the South Fork Holston River near Kingsport controls the river between Boone Reservoir and Cherokee Reservoir. Releases from Fort Patrick Henry coincide with lake level management activities and the need for water at Eastman in Kingsport and the TVA John Sevier steam plant near Rogersville. With the completion of Cherokee Dam in 1941, much of the free flowing characteristics of the river basin within Tennessee were eliminated. Although a "controlled" river, the Holston still boasts a fairly diverse fish assemblage and is home to at least two threatened species (spotfin chub *Erimonax monacha* and snail darter *Percina tanasi*) and thirteen species of freshwater mussels (Ahlstedt 1986).

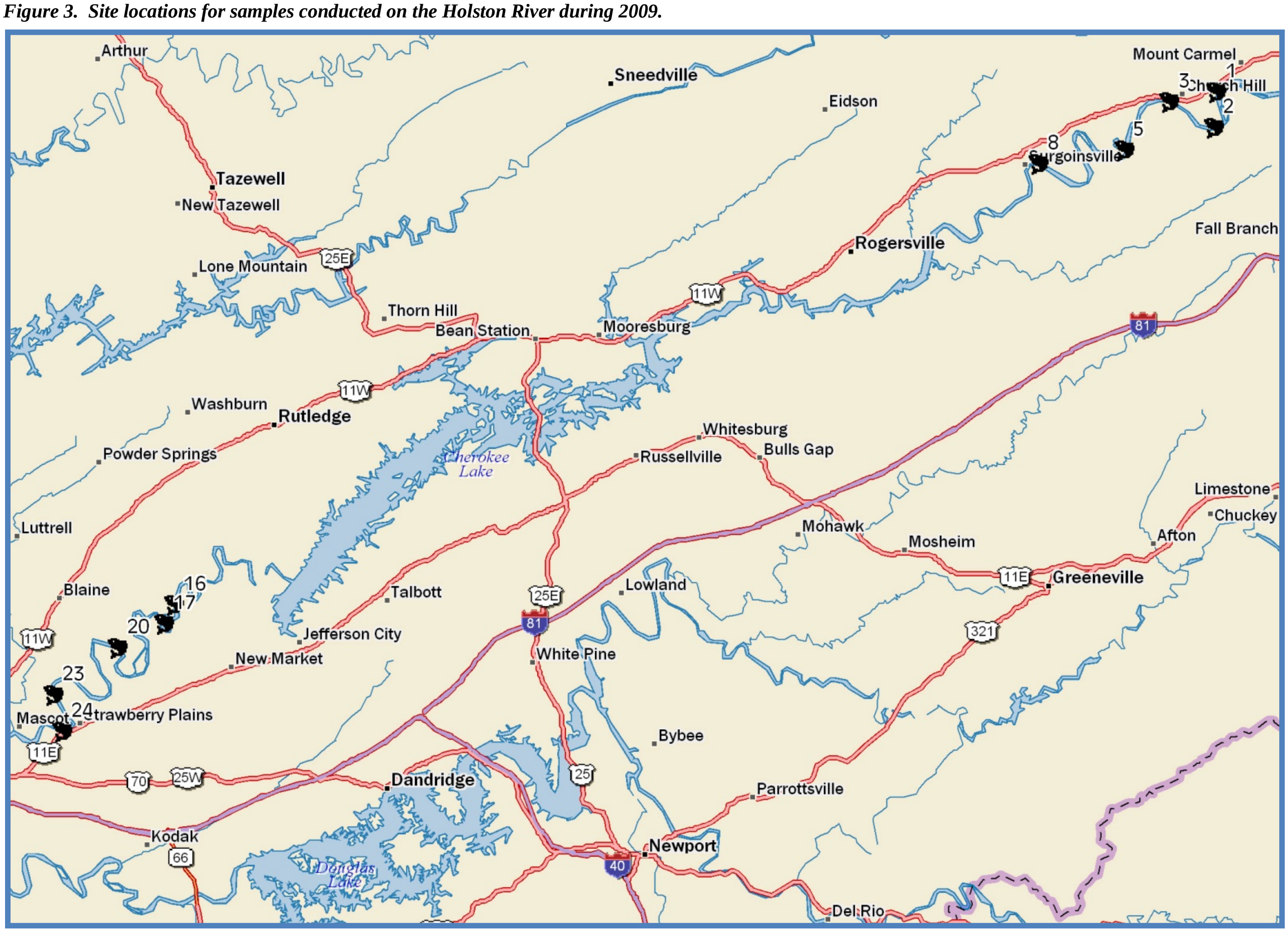
Our 2009 surveys focused on re-evaluating the black bass and rock bass populations in the river above and below Cherokee Dam. We conducted the first intensive survey of the these sport fish species in 2000 (Carter et al. 2001) characterizing black bass and rock bass population structure and developing a fish species list for TADS. Historical surveys have been conducted on the river by various agencies, with the majority of these focusing on community assessment.

Study Area and Methods

The Holston River originates near Kingsport with the confluence of the North Fork Holston and South Fork Holston rivers. These rivers along with the Middle Fork all originate in Virginia. The Holston flows in a southwesterly direction before combining with the French Broad River to form the headwaters of the Tennessee River. The river has a drainage area of approximately 9,780 km^2 at its confluence with the French Broad River. In Tennessee, approximately 184 kilometers of the Holston River flows through the Ridge and Valley ecological province before joining the French Broad River near Knoxville. Public access along the river is primarily private, however, there are some "pull-outs" along public roads paralleling the river. The TWRA manages three public access areas along the river, which include boat ramps near Hunt Creek, the community of Surgoinsville, and Nance Ferry downstream of Cherokee Dam. TVA maintains access below John Sevier Steam Plant and immediately below Cherokee Dam. The cities of Church Hill and Kingsport both have public ramps at their city parks.

Between May 22 and 27 2009, we conducted 10 fish surveys between Kingsport and Mascot (Figure 3). Because this river is a tailwater, habitat availability fluctuates with water releases. However, in our survey sites, the habitat consisted primarily of wooded shorelines with interspersed rock outcroppings.

Figure 3. Site locations for samples conducted on the Holston River during 2009.



Submerged woody debri was scarce in most of our sample areas. The river substrate was predominately bedrock and boulder with some cobble in the riffle areas. Measured channel widths ranged from 68 to 145 m, while site lengths fell between 125 and 1108 m (Table 4). Water temperatures were 19 C upstream of Cherokee Reservoir and 18 C downstream of Cherokee Reservoir. Conductivity varied from 210 to 265 µs/cm (Table 4). Because we were able to conduct the samples earlier in the year we were not hindered by the water star-grass in that portion of the river above Cherokee Reservoir. This made navigating the river much easier and probably increased our sampling efficiency to some degree. In recent years, the river channel becomes choked with this aquatic vegetation making navigation difficult during the summer months.

Table 4. Physiochemical and site location data for samples conducted on the Holston River during 2009.

Site Code	Site	County	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp.	Cond.	Secchi (m)
420070801	1	Hawkins	Church Hill 188SW	136.3	36.52389	-82.68167	127	1108	19	210	1.7
420070802	2	Hawkins	Lovelace 189NW	134.1	36.49740	-82.68520	123	596	-	-	-
420070803	3	Hawkins	Church Hill 188SW	131.5	36.51694	-82.72306	111	375	-	-	-
420070805	5	Hawkins	Stony Point 180NE	127.5	36.48167	-82.76250	145	576	-	-	-
420030608	8	Hawkins	Stony Point 180NE	118.8	36.47167	-82.83833	139	419	-	-	-
420070816	16	Grainger/Jefferson	Joppa 155NE	38.8	36.14972	-83.60167	134.5	468	-	-	-
420070817	17	Grainger/Jefferson	Joppa 155NE	37.5	36.13583	-83.61028	68	125	-	-	-
420070820	20	Grainger/Jefferson	Mascot 155SW	28	36.11861	-83.65139	137.5	654	-	-	-
420070823	23	Jefferson/Knox	Mascot 155SW	19.7	36.08417	-83.70722	144	554	-	-	-
420070824	24	Knox	Mascot 155SW	17	36.05694	-83.70000	107.5	443	18	265	1.0

Fish were collected by boat electrofishing in accordance with the standard large river sampling protocols (TWRA 1998). Fixed-boom electrodes were used to transfer 4-5 amps DC at all sites. This current setting was determined effective in narcotizing all target species (black bass and rock bass). All sites were sampled during daylight hours and had survey durations ranging from 904 to 1595 seconds. Catch-per-unit-effort (CPUE) values were calculated for each target species at each site. Length categorization indices were calculated for target species following Gabelhouse (1984).

Results

CPUE estimates for smallmouth bass above Cherokee Reservoir averaged 100.5/hour (SD 48.4), while the spotted bass and largemouth bass estimates were 0/hour and 0.9/hour (SD 2.0), respectively (Table 5). Comparatively, mean CPUE estimates at the same sites in 2003 and 2007 ranged 108.5/hour to 110.8/hour for smallmouth bass and 1.3/hour to 0.9/hour largemouth bass (Figure 4). No spotted bass have been collected at these sites thus far. Rock bass CPUE was 26.9/hour (SD 34.2) upstream of the reservoir in 2009. This represented a significant increase from a sample taken in 2007and is the second highest value for this species since monitoring began in 2000 (Figure 4). In samples conducted below Cherokee Reservoir in 2009, smallmouth bass catches averaged 86.4/hour (SD 62.1). Spotted bass and largemouth bass catch rates remained low or absent with only one spotted bass being collected in samples. In comparison, the smallmouth bass catch rate rebounded in 2009 over the 2003 and 2007 samples and approached the value recorded in 2000 (Figure 5). This trend stayed in keeping with our theory regarding the smallmouth density trends in relation to the hydrologic cycles. Wet years (2000 and 2009) favor smallmouth bass when compared to drier years (2003 and 2007) due to changes in water release regimes. We have documented unusual age and growth characteristics in this portion of the river as summarized in Carter et al. 2001. This could potentially contribute to population instability. Rock bass catches in this part of the river averaged 32/hour (SD 16) during 2009 (Table 5). This was the lowest recorded value for rock bass in the section of the river since sampling began in 2000 (Figure 5).

Table 5. Catch per unit effort and length-categorization indices of target species collected at ten sites on the Holston River during 2009 (Sites 1-8 above Cherokee Reservoir, sites 16-24 below Cherokee Reservoir).

Site Code	Smallmouth Bass CPUE	Spotted Bass CPUE	Largemouth Bass CPUE	Rock Bass CPUE
420091301	52.2	-	4.5	4.5
420091302	62.9	-	-	7.4
420091303	156	-	-	24
420091305	148	-	-	12
420091308	83.3	-	-	86.6
MEAN	100.5	-	0.9	26.9
STD DEV.	48.4	-	2.0	34.2
Sites 1-8	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis
	PSD = 50.0	PSD = 0	PSD = 0	PSD = 14.3
	RSD-Preferred = 29.2	RSD-Preferred = 0	RSD-Preferred = 0	RSD-Preferred = 0
	RSD-Memorable = 11.1	RSD-Memorable = 0	RSD-Memorable = 0	RSD-Memorable = 0
	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0
420091316	104	-	-	24
420091317	32	-	-	40
420091320	76	-	-	16
420091323	184	4	-	24
420091324	36	-	-	56
MEAN	86.4	0.2	-	32
STD DEV.	62.1	0.4	-	16
Sites 16-24	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis
	PSD = 26.9	PSD = 0	PSD = 0	PSD = 62.1
	RSD-Preferred = 6.4	RSD-Preferred = 0	RSD-Preferred = 0	RSD-Preferred = 8.1
	RSD-Memorable = 1.3	RSD-Memorable = 0	RSD-Memorable = 0	RSD-Memorable = 0
	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0

Figure 4. Trends in mean catch rate of black bass and rock bass collected between 2000-2009 from the Holston River above Cherokee Reservoir.

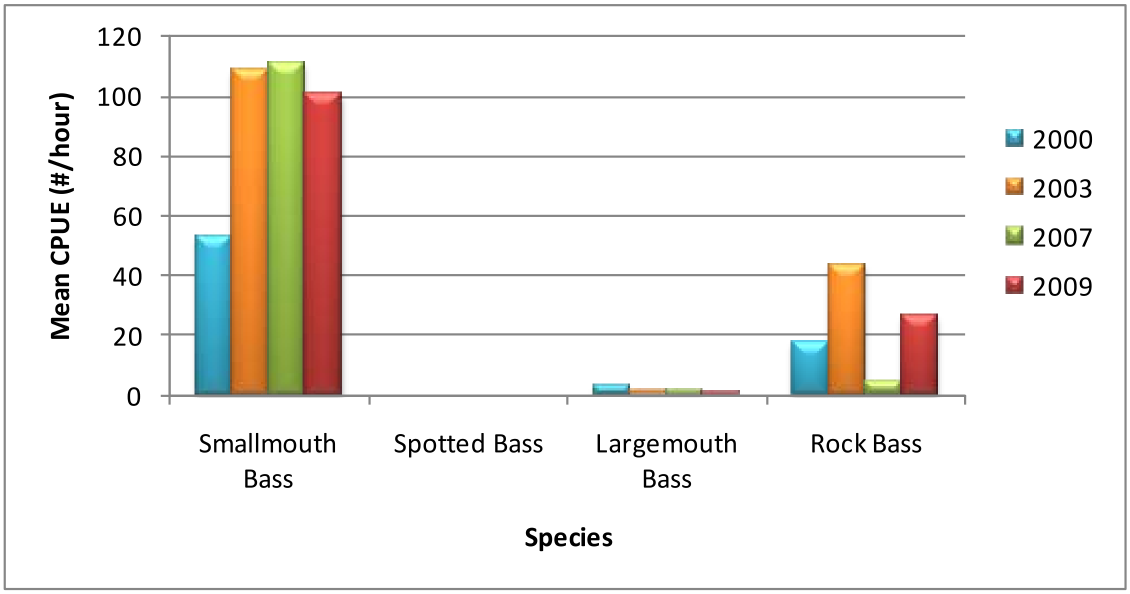
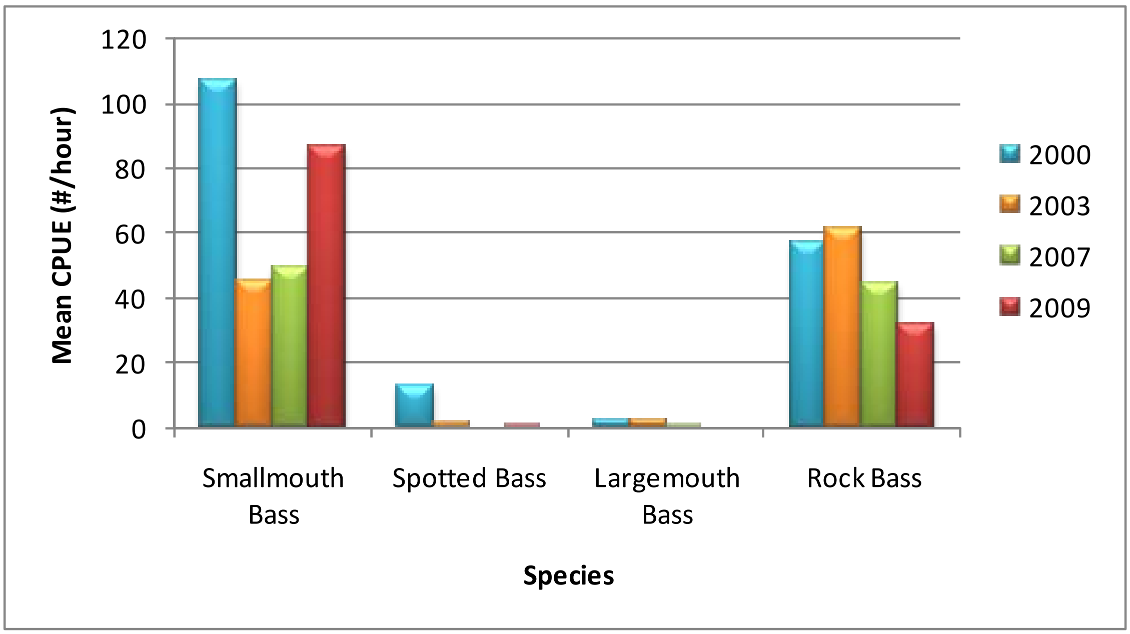
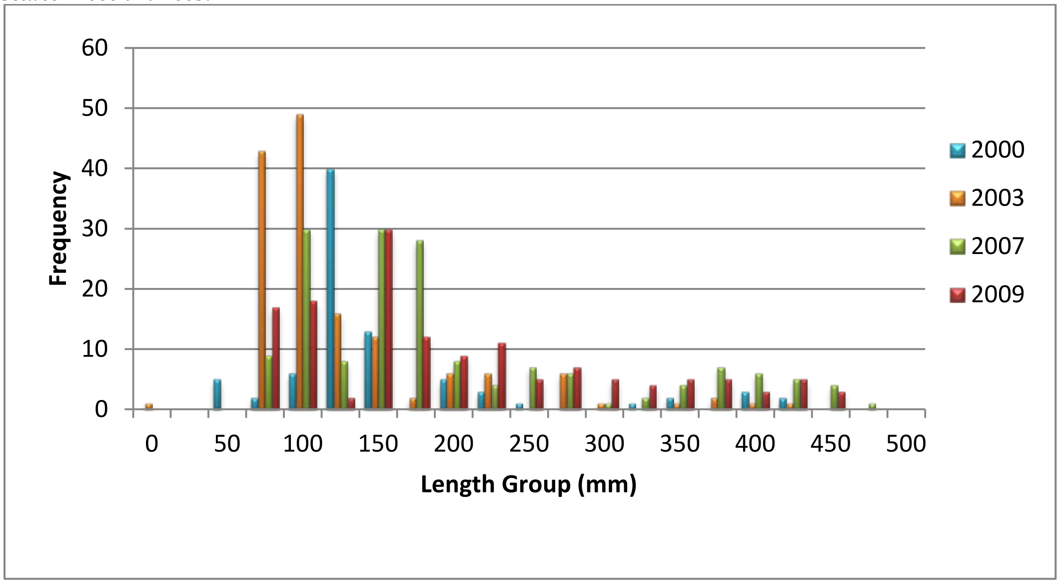


Figure 5. Trends in mean catch rate of black bass and rock bass collected between 2000-2009 from the Holston River below Cherokee Reservoir.



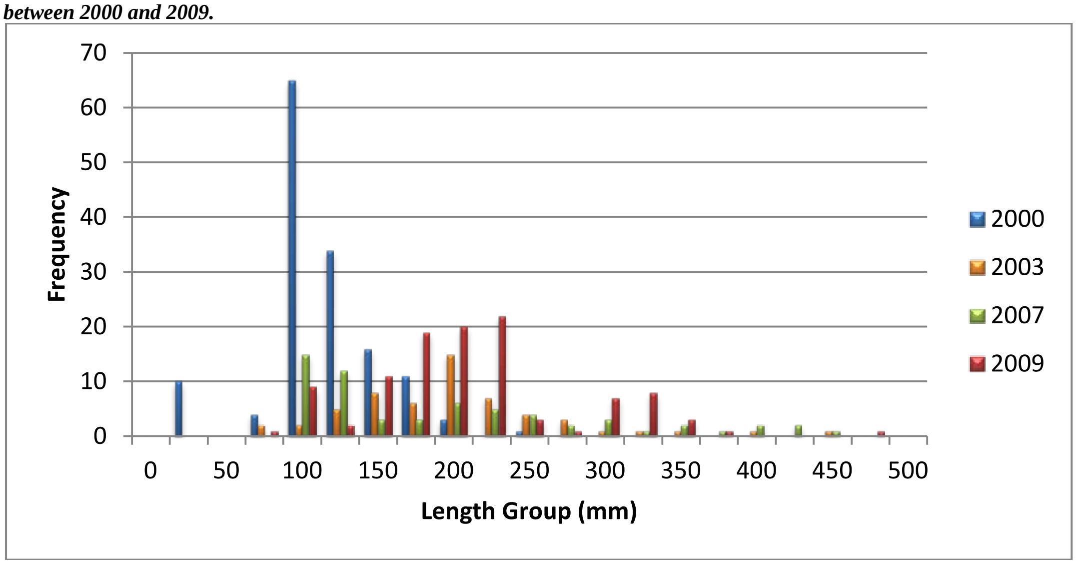
The majority of the smallmouth bass collected from the Holston River collected during 2009 fell within the 75 mm to 250 mm length range both above and below Cherokee Reservoir (Figures 6 and 7). There was a higher representation of smaller bass in the sample taken above Cherokee in 2009 as was the general case for bass over 200 mm (Figure 6). Overall, there was a slight decrease in the number of smallmouth bass 375 mm and larger during 2009.

Figure 6. Length frequency distributions for smallmouth bass collected from the Holston River above Cherokee Reservoir between 2000 and 2009.



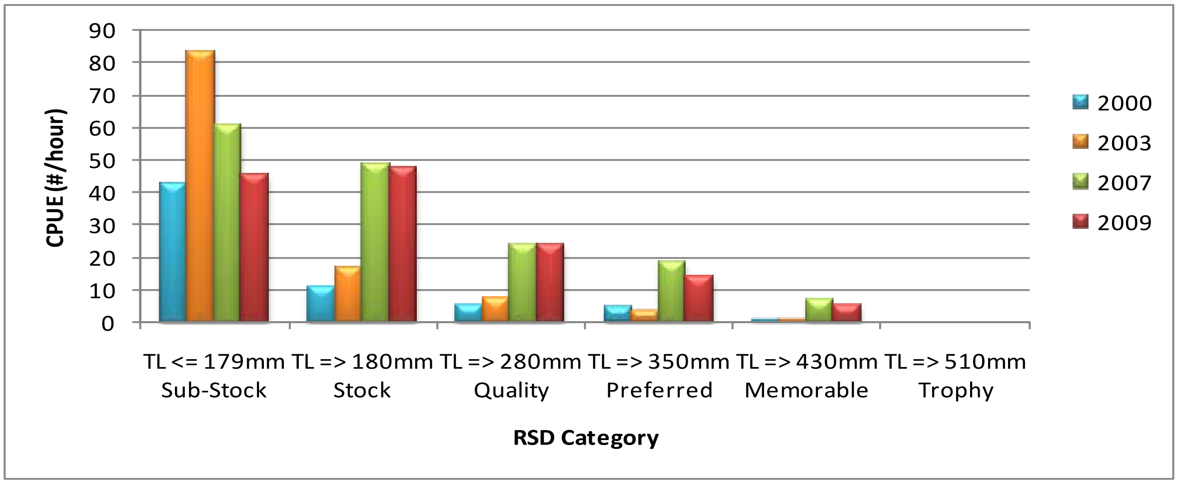
Smallmouth bass below Cherokee Reservoir were most represented by fish in the 150 mm to 250 mm size range (Figure 7). The 2008 year class was relatively weak compared to the 2006 year class which showed good recruitment into the 200 mm and above size classes. Good recruitment in the 300 mm to 375 mm length range would reflect a relatively good 2005 year class based on a 4 year growth period required to reach these size categories in the Holston.

Figure 7. Length frequency distributions for smallmouth bass collected from the Holston River below Cherokee Reservoir between 2000 and 2009.



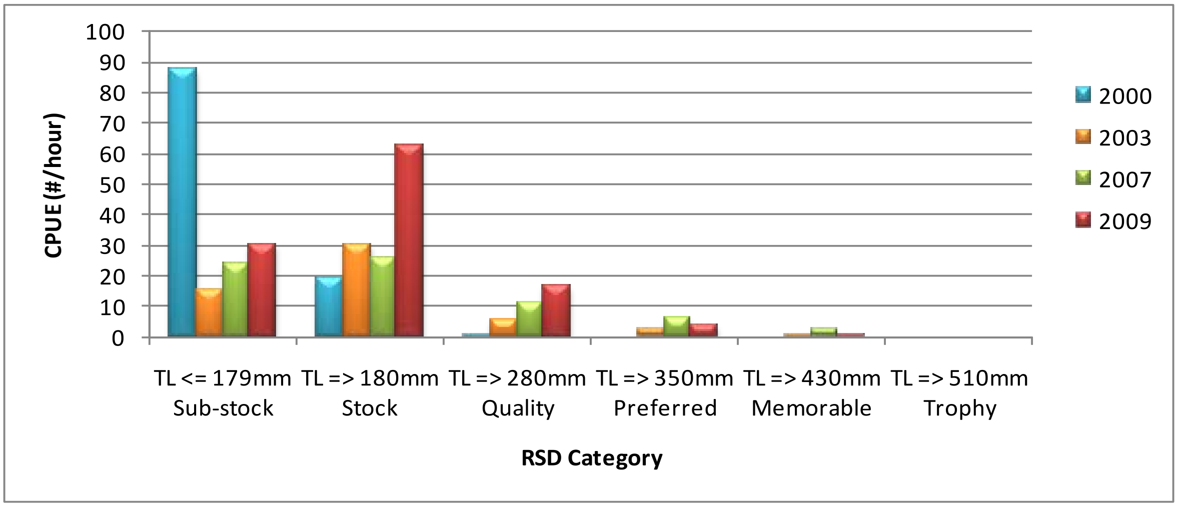
The 2009 Relative Stock Density (RSD) for preferred smallmouth bass (TL $\geq$ 350 mm) above and below the reservoir was 29.2 and 6.4, respectively. The observed values for this same category in 2007 were 38 above the reservoir and 25 below. RSD for memorable (TL $\geq$ 430 mm) and trophy (TL $\geq$ 510 mm) size bass during 2009 were 11.1 and 0 above the reservoir and 1.3 and 0 below the reservoir. Overall we observed a slight decrease in the percentage of preferred and memorable size smallmouth when compared to the previous samples. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 50 above the reservoir and 26.9 below the reservoir during 2009. Catch per unit effort estimates by RSD category above Cherokee Reservoir remained relatively stable during 2009 with the exception of the sub-stock category which showed the greatest decline when compared to 2007 (Figure 8). Although we did not collect any trophy size bass during the 2009 sample we have taken smallmouth in excess of 510 mm (20 in) in this reach of the river.

Figure 8. Relative stock density (RSD) catch per unit effort for smallmouth bass collected in the Holston River above Cherokee Reservoir between 2000 and 2009.



Trends in catch per unit effort by RSD category below Cherokee Reservoir were consistently higher in the majority of the categories when compared to 2007. We observed good recruitment into the stock category and moderate increases in the quality category. We did observe more bass in the quality and above categories than we did in 2000 or 2003 (Figure 9). We did observe good sub-stock recruitment in 2009 although it was only 27% of the value observed in 2000.

Figure 9. Relative stock density (RSD) catch per unit effort for smallmouth bass collected in the Holston River below Cherokee Reservoir between 2000 and 2009.

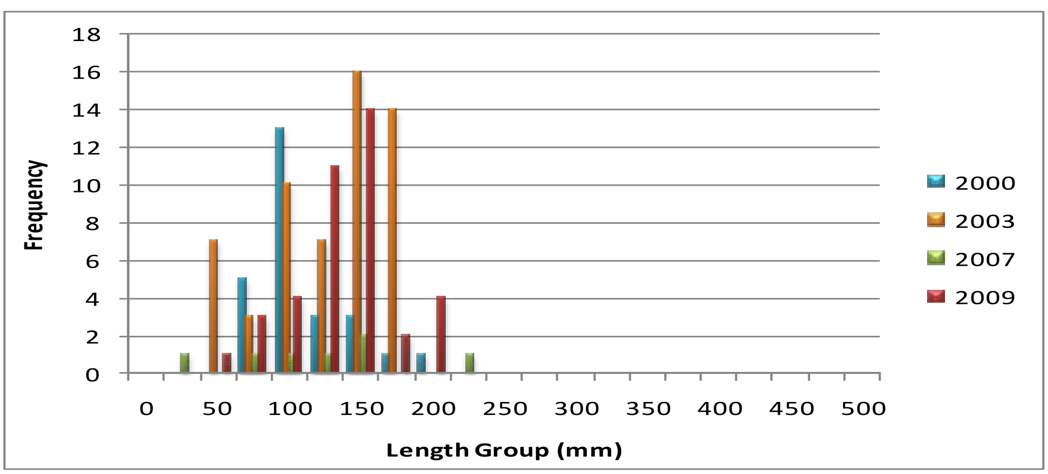


There were no spotted bass collected above Cherokee Reservoir during 2009. Riverine occurrence of spotted bass in most east Tennessee rivers is sporadic at best with the exception of the Nolichucky River where there is a viable fishery for this species. In our samples below Cherokee Reservoir, only one spotted bass was collected.

Because so few largemouth bass were collected in the samples above and below the reservoir during both years it is difficult to make any conclusion regarding these populations. Like spotted bass, largemouth bass tend to occur sporadically and unpredictably in larger rivers of east Tennessee. Where found, they tend to inhabit the more sluggish reaches of rivers usually associated with some type of woody cover.

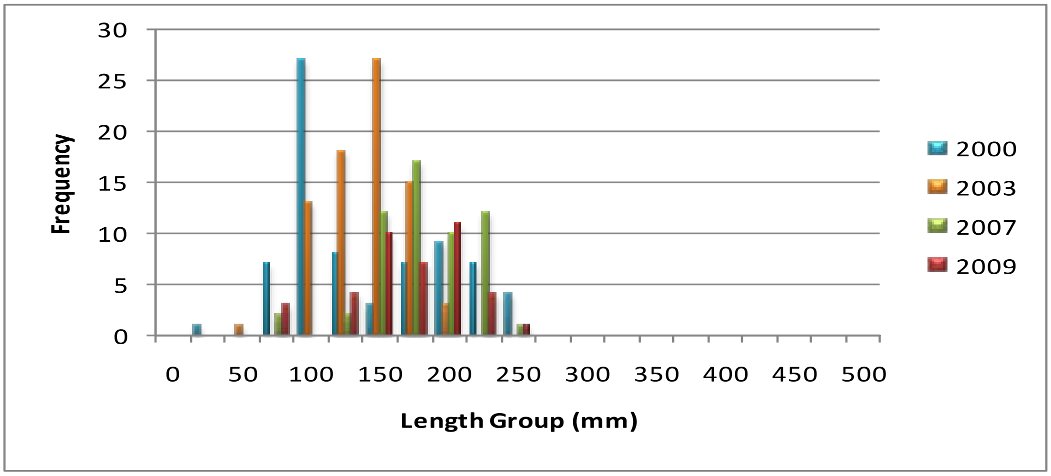
Individuals in the 100 to 175 mm range represented the majority of rock bass in our sample above Cherokee Reservoir (Figure 10). Very few rock bass were collected in 2007 (7), however that number increased substantially in 2009 to 39. Most of the rock bass collected in 2009 came from site 8 which is near Surgoinsville. This sample site has a higher occurrence of preferred habitat in the way of boulder and woody cover along the shoreline. In 2007, the majority of the rock bass collected, came from site 8 which is the farthest downstream in this reach of river. Although rock bass persist in the upper Holston, they are not extremely abundant. Remarks from anglers fishing the river 20 years ago would often refer to the abundance of rock bass in this section of the river. It is unclear why the numbers of rock bass are at the levels currently observed. Since rock bass is a fairly intolerant species it could be several factors such as flow regimes or decrease in habitat quality that are regulating this species. One noticeable change that has taken place in recent history is the significant increase in the growth of aquatic vegetation during the summer months. During peak growth much of the river channel is occupied by river weed or star grass which may have a negative influence on habitat availability for rock bass.

Figure 10. Length frequency distributions for rock bass collected from the Holston River above Cherokee Reservoir between 2000 and 2009.



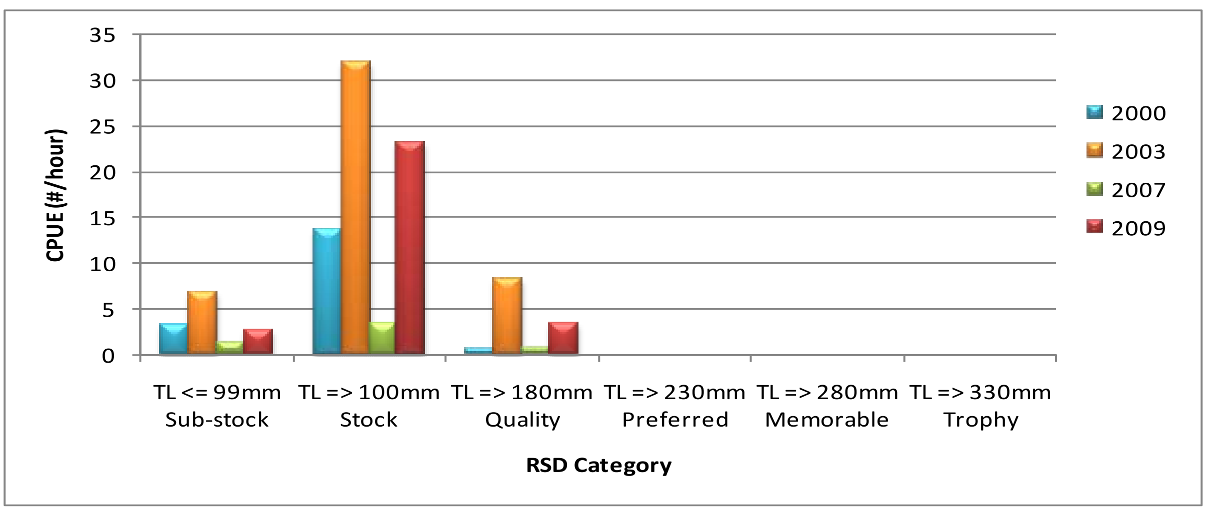
Below Cherokee Reservoir the size distribution for rock bass during the 2009 samples was primarily composed of fish in the 125 to 225 mm size group (Figure 11). Unlike previous years the collection of rock bass below Cherokee reservoir was almost equal to that above the reservoir (39 vs. 40). Historically, the occurrence of rock bass has been disproportionately higher below the reservoir with the exception of 2003 when catches both above and below the reservoir were similar.

Figure 11. Length frequency distributions for rock bass collected from the Holston River below Cherokee Reservoir between 2000 and 2009.



The RSD of preferred (TL ≥ 230 mm) rock bass was 0 above reservoir and 8.1 below the reservoir (Table 6). RSD for memorable (TL ≥ 280 mm) and trophy (TL ≥ 330 mm) size rock bass was 0 both above and below the reservoir. The 2009 PSD of rock bass was 14.3 above the reservoir and 62.1 below the reservoir. Catch per unit effort estimates by RSD category above Cherokee Reservoir indicated the majority of our catch was stock size fish during 2009 (Figure 12). Overall, we did observe increases in all represented categories when compared to the 2007 survey and recorded the second highest values in the represented categories since the initial survey in 2000.

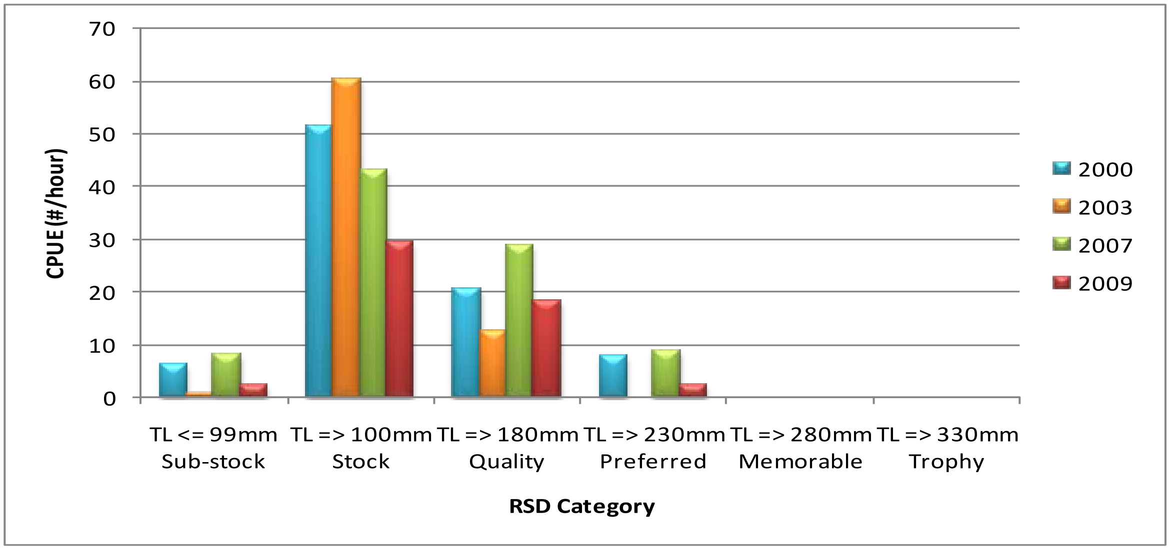
Figure 12. Relative stock density (RSD) catch per unit effort for rock bass collected from the Holston River above Cherokee Reservoir between 2000 and 2009.



In our samples collected below the reservoir we observed lower recruitment into each respective category when compared to previous samples.

Although lower, all size classes represented in prior samples were present in 2009. At this point, it not as clear as to the role hydrologic regimes influence rock bass in this portion of river. Based on the “wet” year samples (2000 and 2009), it would appear that there is not a strong relationship between increased water releases and the abundance of rock bass.

Figure 13. Relative stock density (RSD) catch per unit effort for rock bass collected from the Holston River below Cherokee Reservoir between 2000 and 2009.



Discussion

The Holston River has had a long history of degradation and misuse. Because of the hydropower facilities established on the river much of its free flowing characteristics have been lost, altering the aquatic community and its inhabitants. Mitigation efforts have been conducted in order to establish or re-establish certain suitable species in portions of the river, particularly downstream of Cherokee Reservoir. Between 1997 and 1999, 11,816, 30 to 75 mm smallmouth bass were stocked into the tailwater downstream of Cherokee Dam, in an attempt to bolster the existing population. A put-and-take rainbow trout (*Oncorhynchus mykiss*) fishery was established in the Cherokee tailwater and has become quite popular with local anglers. One threatened species, the snail darter, has been successfully re-introduced into the tailwater near Knoxville and there has been discussion of re-introducing selected mussel species into the river. Lake sturgeon have been introduced into the river below the reservoir. TWRA is considering the experimental release of muskellunge into the river above John Sevier Dam to evaluate the potential for establishing a fishery for this species. TWRA has consulted with the USFWS regarding this issue, and have been given approval for the release.

Efforts made by the Tennessee Valley Authority to improve water quality downstream of Cherokee Dam have for the most part been responsible for the observed improvements below the dam. Dissolved oxygen management in the forbay of Cherokee Reservoir has drastically improved the D.O. levels in the tailwater resulting in restoration projects that would have historically not been considered.

For the most part we were able to improve our sampling efficiency above the reservoir. This was due to the lack of aquatic vegetation during our sample. The proliferation of aquatic vegetation during the summer months makes sampling the river above the reservoir difficult. Because of this we have shifted our sampling strategy to the spring months both above and below the reservoir. Our next scheduled sample of the Holston River will be in 2012.

Management Recommendations

1. Continue the Cherokee tailwater rainbow and brown trout put-and-take program.

2. Initiate an angler use and harvest survey.

3. Develop a fishery management plan for the river.

4. Continue to cooperate with lake sturgeon re-introduction efforts.

5. Consider developing a muskellunge fishery in the river above John Sevier Dam.

French Broad River

Introduction

Like many of the larger rivers in east Tennessee, the French Broad has a long history of pollution related problems stemming from industry, urbanization, and agricultural activities within the watershed. Ichthyological studies within the watershed date back to the mid to late 1800's when Cope and Jordan made some of the first collections in the river (Harned 1979). The TVA (Harned 1979) probably conducted the most comprehensive survey of the river and watershed tributaries to date. One hundred seventeen sample stations were surveyed on the mainstem French Broad and four of its tributaries during the summer of 1977.

Study Area and Methods

The French Broad River originates near Rosman, North Carolina and flows in a southwesterly direction before combining with the Holston River near Knoxville to form the Tennessee River. The French Broad has a drainage area of 13,177 km^2 and courses some 349 km from its headwaters to the confluence with Holston River (Harned 1979). The French Broad is located in the Blue Ridge physiographic province in North Carolina and a small portion of Tennessee (Cocke Co.). The river transitions into the Ridge and Valley physiographic province near Newport. There is one large reservoir located on the French Broad in Tennessee, Douglas Reservoir, located in Jefferson and Sevier counties. The reservoir impounds approximately 69 km of river channel and spreads out over 12,302 hectares (Harned 1979). The elevational profile of the river is quite impressive with the steepest fall observed from Asheville, North Carolina to Newport, Tennessee. Within Tennessee, the river descends about 477 feet between the state line and Knoxville.

The river downstream of Douglas Dam is one of the few warmwater tailwaters in east Tennessee. It is managed under a minimum flow regime by the Tennessee Valley Authority (TVA) to provide recreational opportunities and to ensure that water quality remains at acceptable levels. Since the improvements in water quality below the dam, several restoration projects have been initiated. These include the introduction of the lake sturgeon and selected species of mollusks. The snail darter has in recent years, colonized the river from stockings made in the Holston River and has established a resident population. The snail darter is currently listed as threatened by the U.S. Fish and Wildlife Service.

Between April 27 and August 18, 2009 we sampled 14 sites (5 above Douglas Reservoir, 9 below Douglas Reservoir) (Figures 14 and 15). Boat electrofishing was used at both localities. Due to the nature of the river above Douglas Reservoir, we used our inflatable cataraft to survey this section of the river. This boat allows us to survey in rough water where conventional aluminum electrofishing boats do not work.

Figure 14. Locations of samples conducted in the French Broad River above Douglas Reservoir during 2009.

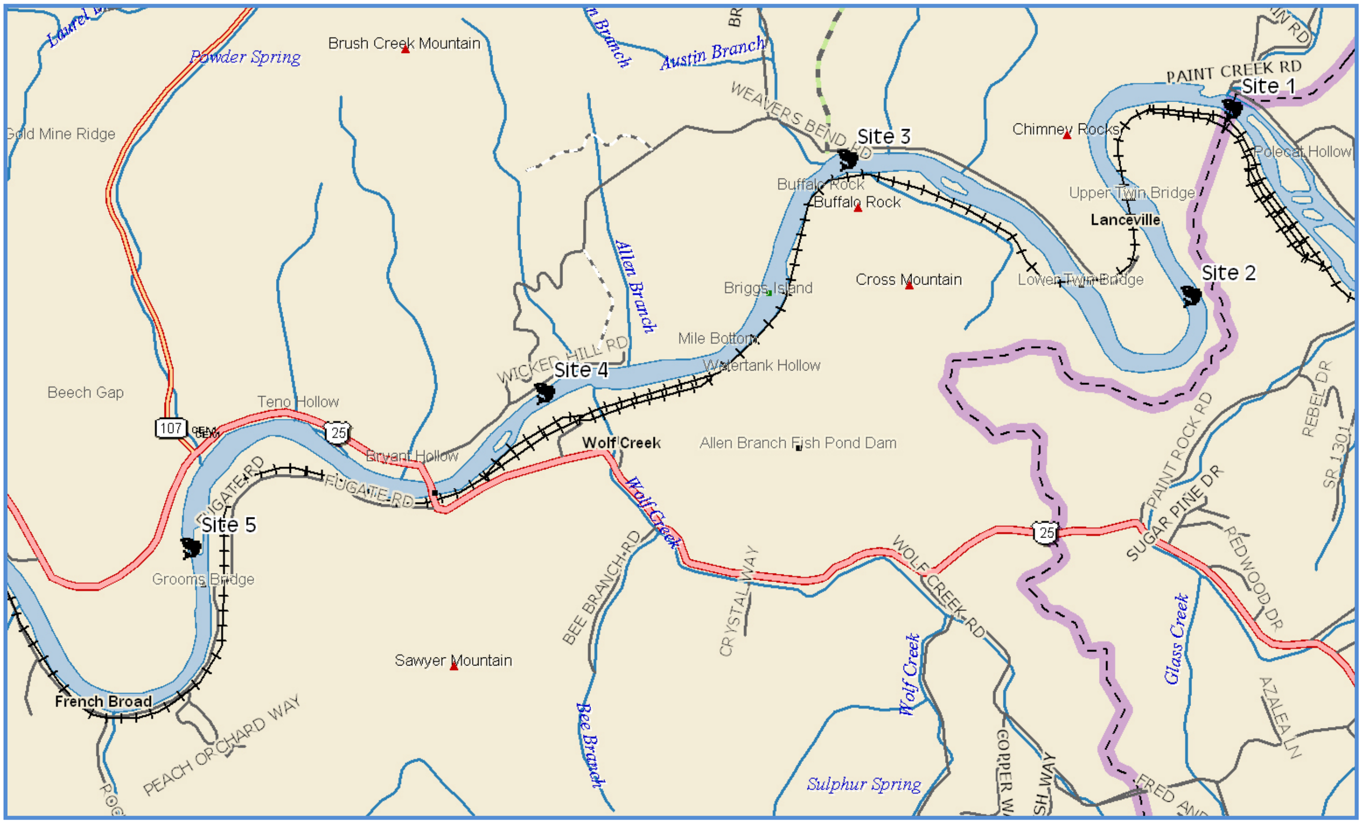
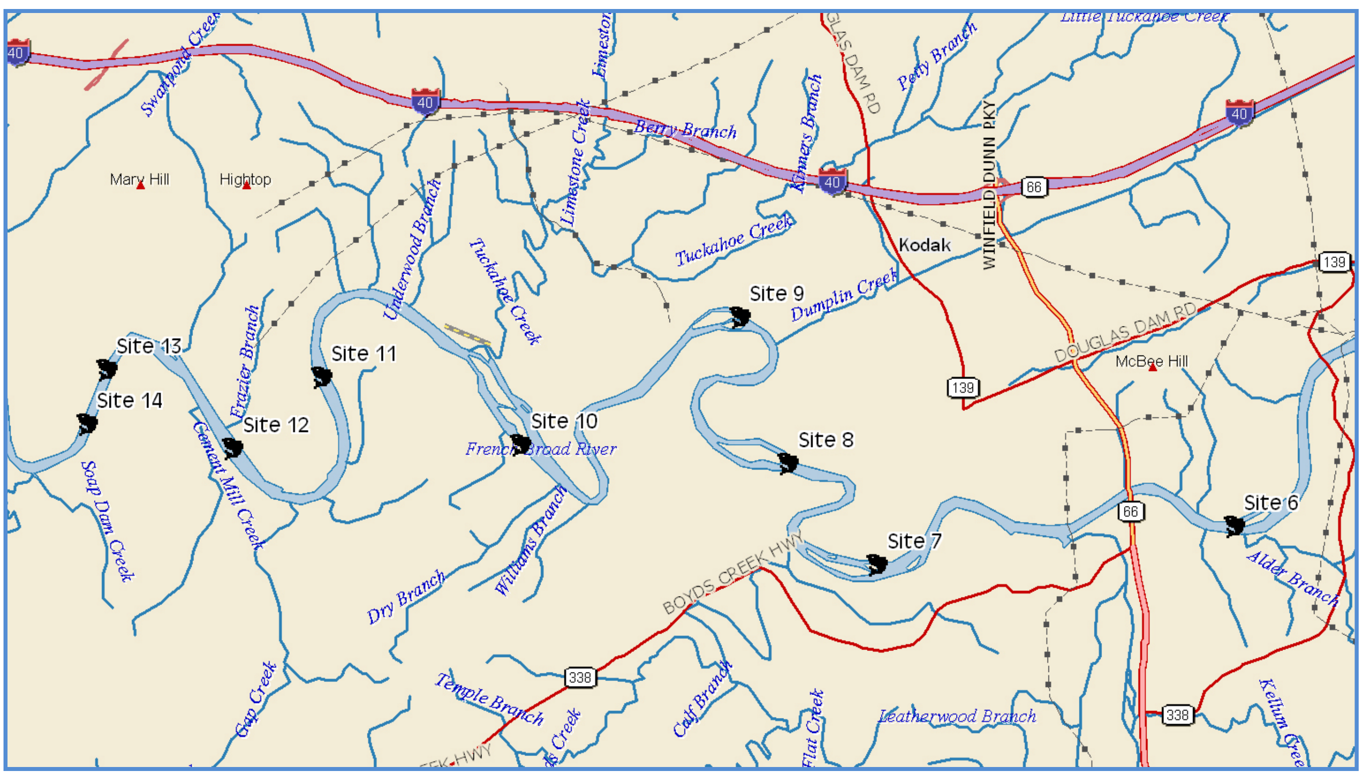


Figure 15. Site locations for samples conducted in the French Broad River below Douglas Reservoir during 2009.



In the reach of river we sampled, the native riparian vegetation was for the most part intact. There seemed to be more agricultural development in the tailwater reach of the river due to more suitable topography. Submerged woody debris was scarce in most of our sample areas. The river substrate was predominately bedrock and boulder with some cobble in the riffle areas. Measured channel widths ranged from 61 to 304 m, while site lengths fell between 230 and 1246 m (Table 6). Water temperatures ranged from 17 to 27.5 C. Conductivity varied from 75 to160 µs/cm (Table 6).

Table 6. Physiochemical and site location data for samples conducted on the French Broad River during 2009.

Site Code	Site	County	Quad	River Mile	Latitude	Longitude	Mean Width (m)	Length (m)	Temp.	Cond.	Secchi (m)
420070701	1	Cocke	Paint Rock 182NW	99.5	35.94394	-82.89837	109	500	22	75	0.7
420070702	2	Cocke	Paint Rock 182NW	98.9	35.93274	-82.90164	86	494	26	75	0.7
420070703	3	Cocke	Paint Rock 182NW	97.3	35.94114	-82.9277	72	496	27	78	0.7
420070704	4	Cocke	Paint Rock 182NW	95.3	35.92685	-82.95068	85.5	431	27.5	78	0.7
420070705	5	Cocke	Paint Rock 182NW	93.6	35.91739	-82.97733	61	230	26.5	79	0.7
420070706	6	Sevier	Douglas Dam 156NE	29.5	35.93250	-83.56306	146.6	1246	-	-	1.8
420070707	7	Sevier	Douglas Dam 156NE	25.1	35.92667	-83.63028	221	551	-	-	1.8
420070708	8	Sevier	Boyds Creek 156NW	22.4	35.94222	-83.64694	91.5	845	-	-	1.8
420070709	9	Sevier	Boyds Creek 156NW	19.5	35.96444	-83.65611	167	1027	17	158	1.8
420070710	10	Knox	Boyds Creek 156NW	15.5	35.94500	-83.69722	304	818	18	160	1.8
420070711	11	Knox	Boyds Creek 156NW	11.8	35.95528	-83.73472	175	759	-	-	1.8
420070712	12	Knox	Boyds Creek 156NW	9.3	35.94472	-83.75111	183	927	-	-	1.8
420070713	13	Knox	Shooks Gap 147NE	7.3	35.95639	-83.77472	127	277	-	-	1.8
420070714	14	Knox	Shooks Gap 147NE	6.6	35.94806	-83.77806	123	921	-	-	1.8

Fish were collected by boat electrofishing in accordance with the standard large river sampling protocols (TWRA 1998). Fixed-boom electrodes were used to transfer 4-5 amps DC at all sites. This current setting was determined effective in narcotizing all target species (black bass and rock bass). All sites were sampled during daylight hours and had survey durations ranging from 522 to 2200 seconds. Catch-per-unit-effort (CPUE) values were calculated for each target species at each site. Length categorization indices were calculated for target species following Gabelhouse (1984).

Results

CPUE estimates for smallmouth bass above Douglas Reservoir averaged 23.3/hour (SD 9.8), while the spotted bass and largemouth bass estimates were 1.6/hour (SD 3.5) and 0/hour, respectively (Table 7). Comparatively, mean CPUE estimates in 2007 were 14.6/hour for smallmouth bass and 2.6/hour for spotted bass (Figure 16). The smallmouth bass catch increased 59.5% when compared to 2007. No rock bass were collected in the river upstream of the reservoir although they were present in 2007. In samples conducted below Douglas Reservoir in 2009, smallmouth bass catches averaged 77.9/hour (SD 57.5). Spotted bass and largemouth bass catch rates were not surprisingly lower at 10.2/hour (SD 8.6) and 1.9/hour (SD 2.9), respectively. In comparison, the CPUE value for smallmouth bass in 2007 was about 48% lower than the value recorded in 2009 (Figure 17). Rock bass catches in this part of the river averaged 78.6/hour (SD 65.2) during 2009 (Table 7). This was about 125% higher than the value recorded in 2007(Figure 17).

Table 7. Catch per unit effort and length categorization indices of target species collected at 14 sites on the French Broad River during 2009 (Sites 1-5 above Douglas Reservoir, sites 6-14 below Douglas Reservoir).

Site Code	Smallmouth Bass CPUE	Spotted Bass CPUE	Largemouth Bass CPUE	Rock Bass CPUE
420090701	18.2	-	-	-
420090702	35	-	-	-
420090703	11.4	-	-	-
420090704	32	-	-	-
420090705	20	8	-	-
MEAN	23.3	1.6	-	-
STD. DEV.	9.8	3.5	-	-
Sites 1-5	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis
	PSD = 14.8	PSD = 0	PSD = 0	PSD = 0
	RSD-Preferred = 3.7	RSD-Preferred = 0	RSD-Preferred = 0	RSD-Preferred = 0
	RSD-Memorable = 0	RSD-Memorable = 0	RSD-Memorable = 0	RSD-Memorable = 0
	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0
420090706	8.3	5.5	5.5	5.5
420090707	125	-	-	163.8
420090708	136.6	3.3	-	136.6
420090709	37.7	18	-	42.6
420090710	43.3	16.6	6.6	33.3
420090711	64	8	-	184
420090712	180	-	-	60
420090713	78.5	21.4	-	57.1
420090714	27.7	19.4	5.5	25
MEAN	77.9	10.2	1.9	78.6
STD. DEV.	57.5	8.6	2.9	65.2
Sites 6-14	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis	Length-Categorization Analysis
	PSD = 19.1	PSD = 38.4	PSD = 25	PSD = 31.4
	RSD-Preferred = 11.6	RSD-Preferred = 0	RSD-Preferred = 25	RSD-Preferred = 4.2
	RSD-Memorable = 4.1	RSD-Memorable = 0	RSD-Memorable = 0	RSD-Memorable = 0
	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0	RSD-Trophy = 0

Figure 16. Trends in mean catch rate of black bass and rock bass collected from 2000-2009 in the French Broad River above Douglas Reservoir.

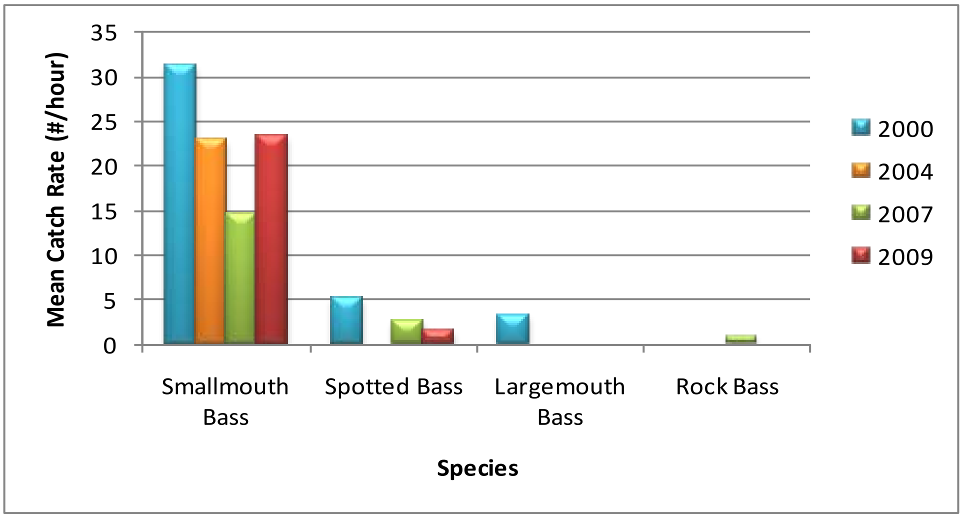
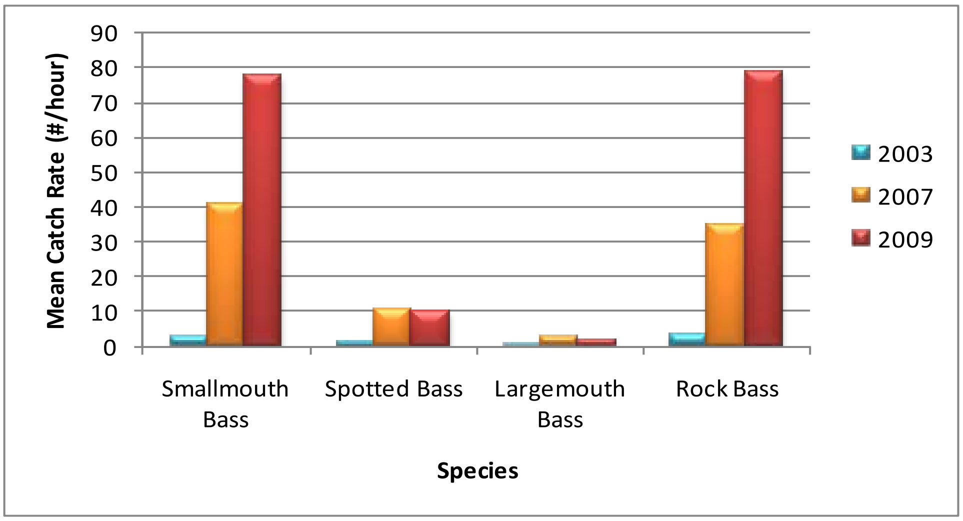
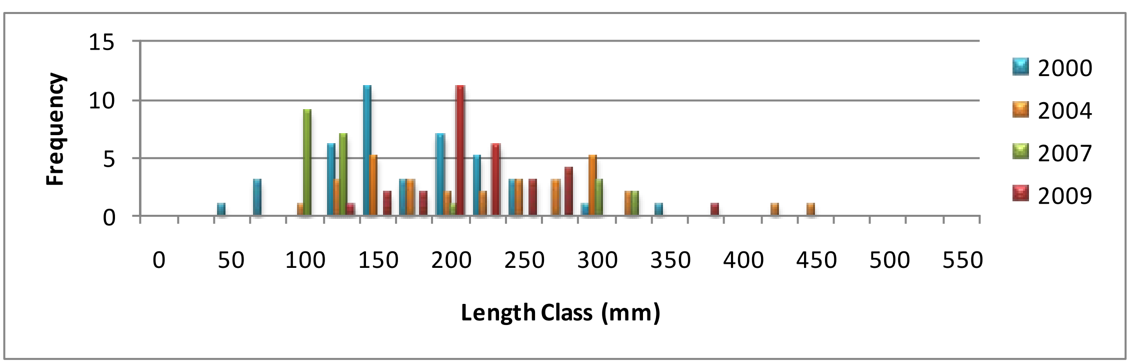


Figure 17. Trends in mean catch rate of black bass and rock bass collected from 2003-2009 in the French Broad River below Douglas Reservoir.



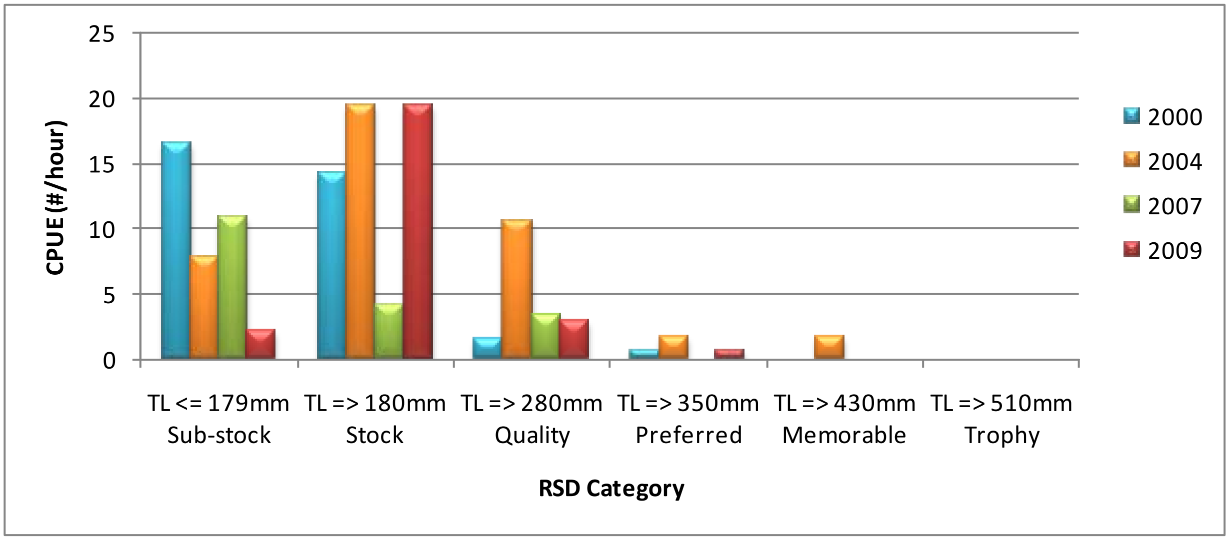
The length distribution of smallmouth bass above Douglas Reservoir was predominantly comprised of individuals in the 200 to 275 mm size range. There was only one bass over 300 mm (12 in) collected during 2009 in this reach of the river (Figure 18).

Figure 18. Length frequency distributions for smallmouth bass collected from the French Broad River above Douglas Reservoir between 2000 to 2009.



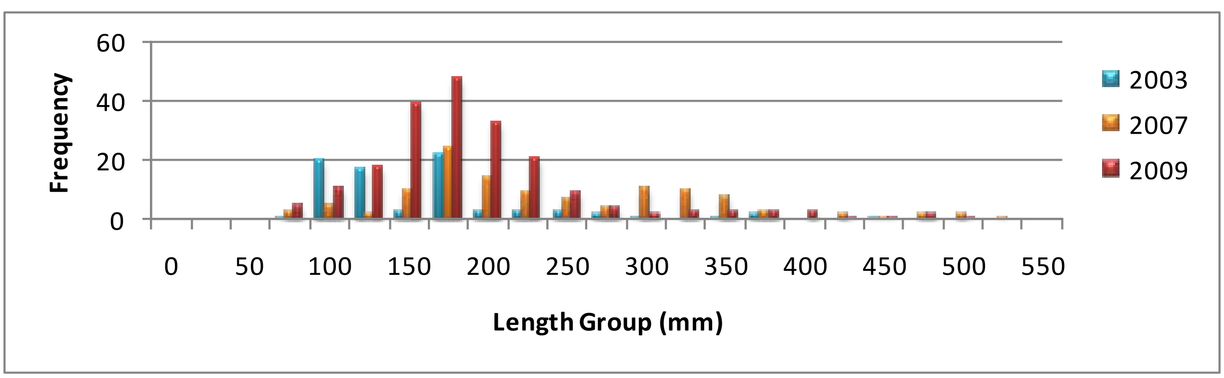
The 2009 Relative Stock Density (RSD) for preferred smallmouth bass (TL $\geq$ 350 mm) above the reservoir was 3.7. This was an increase from 2007 when no bass in the preferred category were collected (Figure 19). With the exception of the sub-stock category we observed either increases or consistency in all the represented categories when compared to 2007. The PSD of smallmouth bass (ratio of quality size bass to stock size bass) was 14.8 above the reservoir indicating a relatively low number of quality size bass in the population. The relative strength of the stock category in 2009 is encouraging for bolstering the size structure in coming years providing recruitment remains proportional. We did collect fish in the preferred category which has not occurred since 2004.

Figure 19. Relative stock density (RSD) catch per unit effort by category for smallmouth bass collected from the French Broad River above Douglas Reservoir between 2000 and 2009.



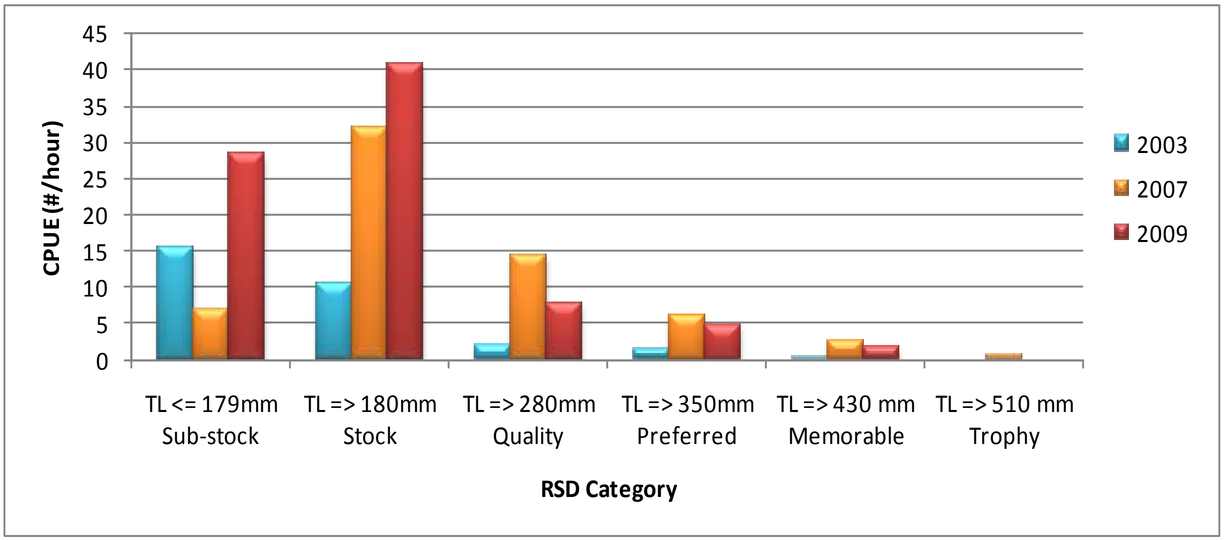
The length distribution of smallmouth bass below Douglas Reservoir was predominantly comprised of individuals in the 100 to 225 mm size range. We did collect one bass that was 19.6 inches. Overall, the abundance of quality size bass in this section of the river was lower when compared to 2007 (Figure 20).

Figure 20. Length frequency distribution for smallmouth bass collected from the French Broad River below Douglas Reservoir between 2003 and 2009.



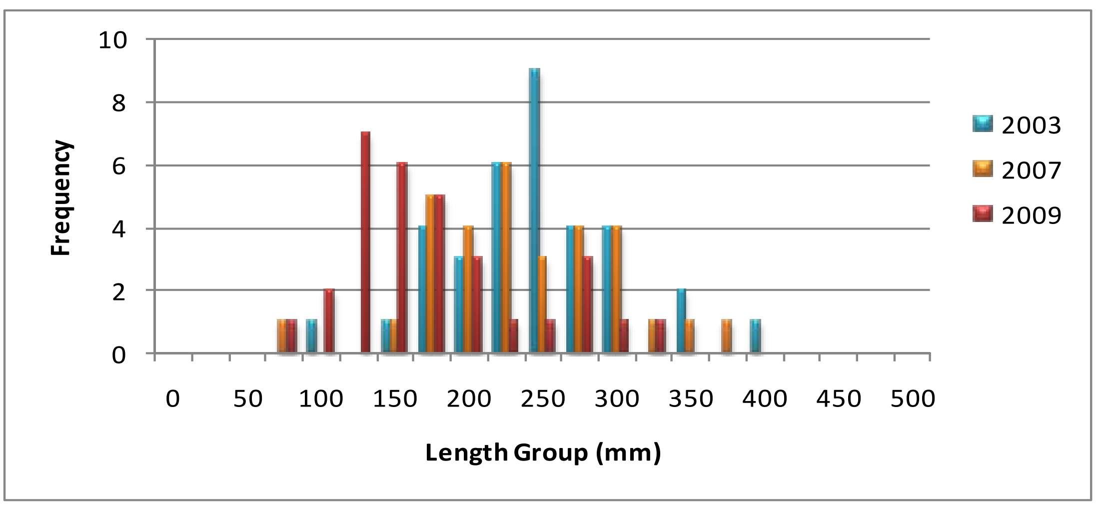
Trends in catch per unit effort by RSD category below Douglas Reservoir appeared to be more robust in 2009. With the exception of the trophy category all size groups were well represented in 2009. There was a slight decrease in the catch of preferred and memorable size smallmouth and a more noticeable decline in the quality bass when compared to 2007. Sub-stock and stock categories increased in 2009 with the most significant increase in the sub-stock category (Figure 21). The PSD for smallmouth bass decreased to 19.1 in 2009 from 45.3 in 2007 reflecting the preponderance of stock size bass in relation to the number of quality size bass. We did catch bass in every RSD category with the exception of the trophy category.

Figure 21. Relative stock density (RSD) catch per unit effort by category for smallmouth bass collected from the French Broad River below Douglas Reservoir between 2003 and 2009.



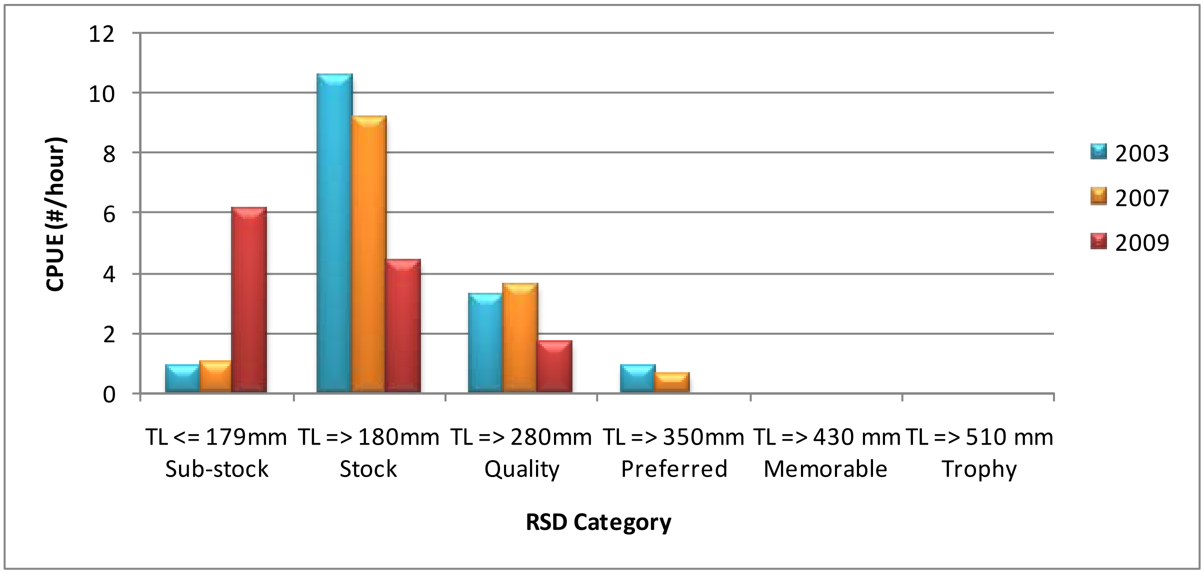
The majority of spotted bass collected from the French Broad River during 2009 fell within the 125 mm to 225 mm length range (Figure 22). Only two spotted bass were collected from the upper French Broad, ranging from 200 mm to 350 mm. Because of the low number, no analyses were conducted for these fish.

Figure 22. Length frequency distribution for spotted bass collected in the French Broad River below Douglas Reservoir between 2003 and 2009.



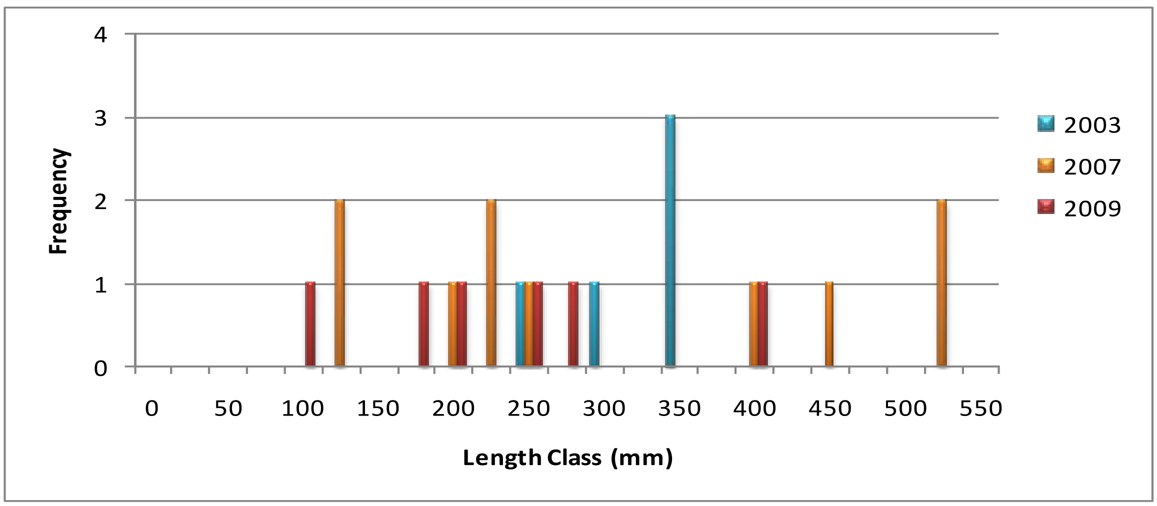
Length categorization analysis indicated the RSD for preferred spotted bass (TL ≥ 350 mm) in the lower French Broad was 0. This was down from 7.1 in 2007. RSD for memorable (TL ≥ 430 mm) and trophy (TL ≥ 510 mm) size bass was 0. The PSD of spotted bass was 38.4 which was comparable to the value in 2007. Catch per unit effort estimates by RSD category revealed a decrease in all represented categories between 2007 and 2009 with the exception of sub-stock (Figure 23).

Figure 23. Relative stock density (RSD) catch per unit effort by category for spotted bass collected from the French Broad River below Douglas Reservoir between 2003 and 2009.



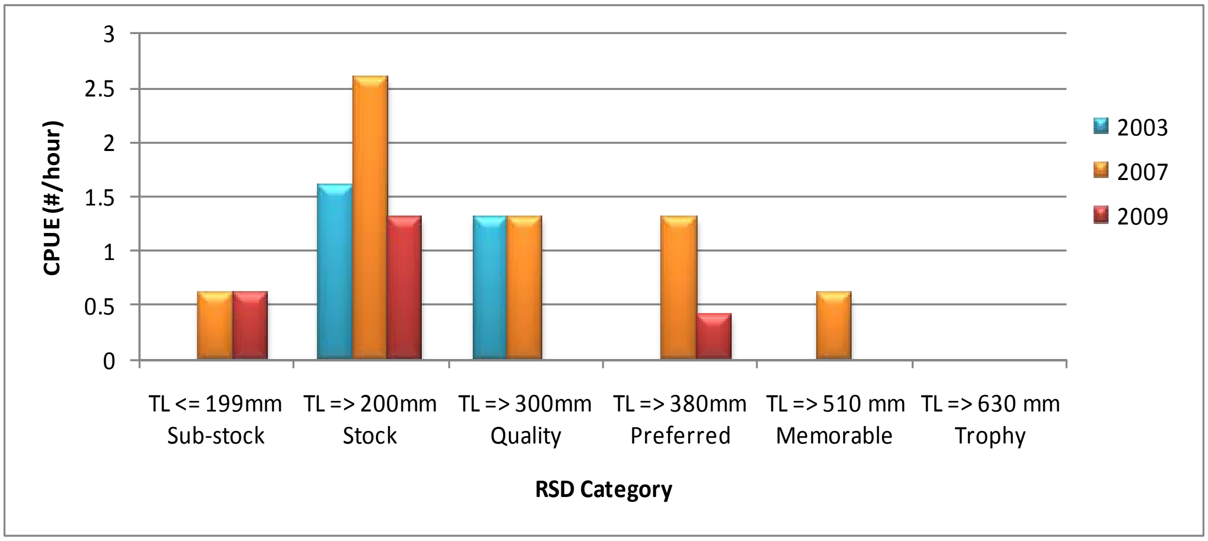
Very few largemouth bass were collected in the French Broad during 2009. None were collected in samples above Douglas Reservoir. Of those collected below the reservoir, all fell within the 100 mm and 425 mm length range (Figure 24).

Figure 24. Length frequency distributions for largemouth bass collected from the French Broad River below Douglas Reservoir between 2003 and 2009.



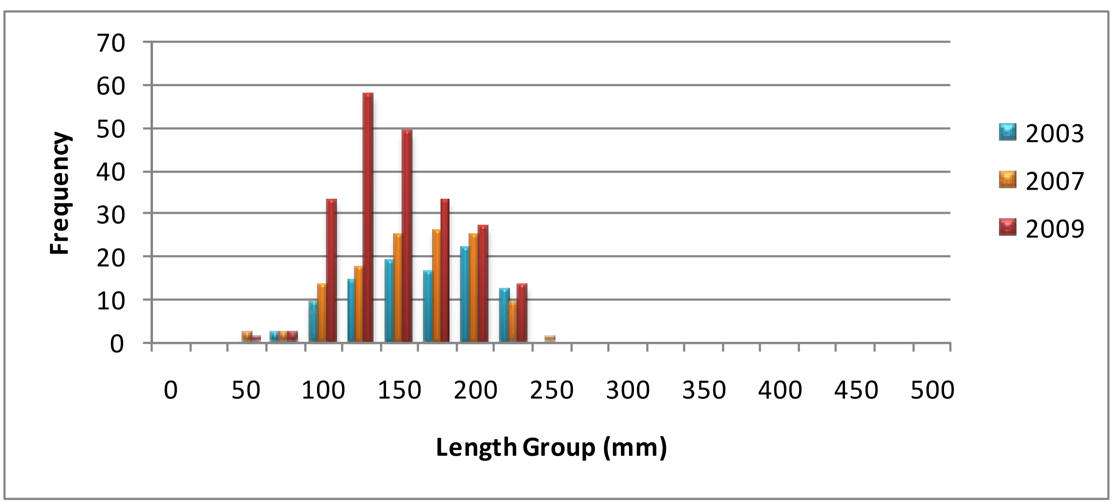
Our collection of largemouth bass dropped from 10 to 6 between 2007 and 2009 below Douglas Reservoir. Length categorization analysis indicated the RSD for preferred largemouth bass (TL ≥ 380 mm) was 25. RSD for memorable (TL ≥ 510 mm) and trophy (TL ≥ 630 mm) size largemouth bass was 0. The PSD of largemouth bass was 25. The highest catch rate by RSD category was for stock size largemouth bass (Figure 25).

Figure 25. Relative stock density (RSD) catch per unit effort by category for largemouth bass collected from the French Broad River below Douglas Reservoir between 2003 and 2009.



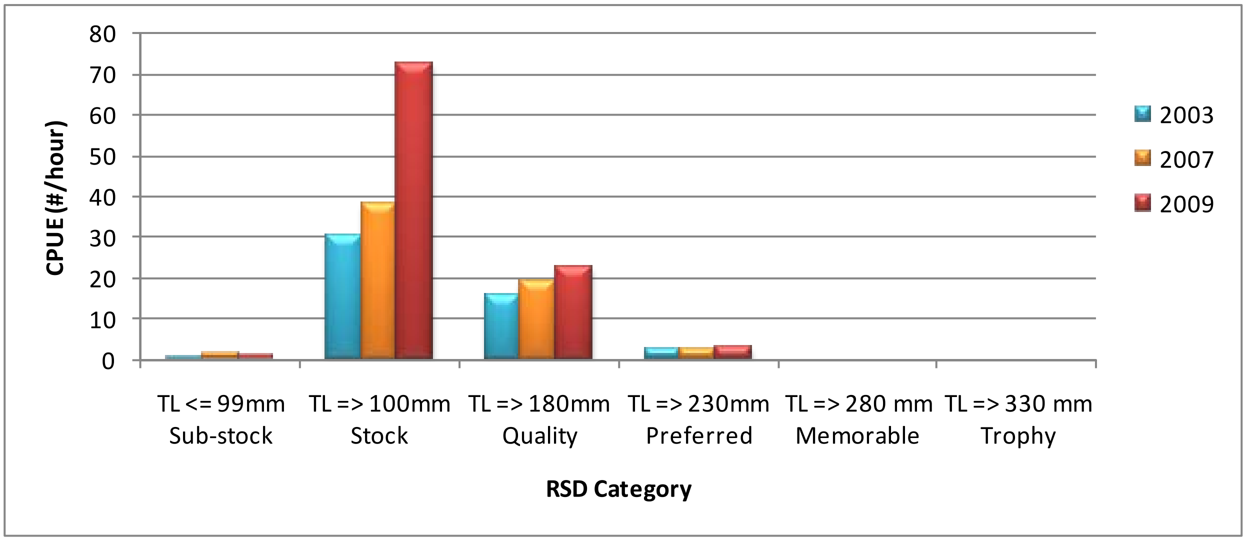
We did not collect any rock bass in the French Broad above Douglas Reservoir in 2009 (one was collected in 2007). A total of 216 rock bass were collected in our survey of the lower French Broad River. The size distribution was fairly typical of other riverine populations with the bulk of the fish falling in the 100 mm to 225 mm length range (Figure 26). Although the size distribution was similar between samples, the frequency of rock bass in each respective size category was greater in 2009 for the majority of the represented size classes.

Figure 26. Length frequency distributions for rock bass collected from the French Broad River below Douglas Reservoir between 2003 and 2009.



PSD for the rock bass population in the lower French Broad was 31.4. The value for preferred rock bass (TL $\geq$ 230 mm) was 4.2. Memorable (TL $\geq$ 280 mm) and trophy (TL $\geq$ 330 mm) rock bass values were 0. Sub-stock catch of rock bass was low (Figure 27), however, this does not necessarily indicate the lack of reproduction. The vulnerability of these smaller fish to the electrofishing gear is considerably lower than larger size groups. Recruitment of rock bass into the stock and quality size was good with about 31% of the catch comprised of quality (TL > 180 mm) size fish or larger (Figure 27). Our catch rate of preferred rock bass increased slightly over the value in 2007.

Figure 27. Relative stock density (RSD) catch per unit effort by category for rock bass collected in the French Broad River below Douglas Reservoir between 2003 and 2009.



Discussion

The French Broad River represents a valuable resource for the state. Although degraded over the years from residential, municipal, and agricultural growth, the river has seen improvement in water quality and maintains many of its scenic and natural characteristics. It supports and active whitewater rafting industry and is an important recreational resource for local residents. The fishery above Douglas reservoir is moderate at best, but does provide adequate angling opportunities that deserve management consideration. Probably the most abundant species we have encountered that would be sought by anglers is the channel catfish. In the tailwater section of the river below Douglas Reservoir, smallmouth bass fishing opportunities could be ranked as one of the region's best, producing some trophy size bass and numerous smallmouth that would be considered quality size. Water quality improvements to the tailwater section of the river by TVA have allowed for the recovery of selected species of fish and mussels. The snail darter, listed as threatened, is the most notable success story in the tailwater. Lake sturgeon stockings into the tailwater are continuing in hopes of recovering this species to some of its former range.

The establishment of a musky fishery in the reach of river upstream of Douglas Reservoir was initiated in 2009. The North Carolina Wildlife Resource

Commission currently stocks 1,000 to 1,500 musky (Ohio Strain) in the French Broad River every other year (Scott Loftis, NCWRC, pers comm.) and until 2009 was the only possibility for musky to enter the Tennessee portion of the river. Between July 22 and August 21, 2009 we were able to release 4,559 musky in the French Broad between river mile 77.4 and 100. The July release was comprised of 300 (mean TL 104 mm) Ohio strain musky originating from Table Rock Hatchery in North Carolina. The second stocking in August consisted of 4,259 (mean TL 151 mm) mixed strain musky from East Fork Hatchery in Indiana. Although both groups of fish were not the optimal size for release, we are hopeful that a small percentage will recruit. We will continue to pursue out sources of musky for release into the French Broad as TWRA currently does not have a musky production program.

Access along the river is somewhat limited, although a good portion of the upper reach of the river is located on U.S. Forest Service land. There is one developed access point upstream of Douglas Reservoir that is maintained by the USFS. Developed public access downstream of Douglas Reservoir is limited to ramps at Douglas Dam (TVA), Highway 66 Bridge (TWRA) near Sevierville, Seven Islands and at Huffaker Ferry in Kodak. There are a few primitive ramps and pull-outs along some of the roads paralleling the river above and below Douglas Reservoir. We are scheduled to return to the French Broad in 2012 to sample sites above and below Douglas Reservoir.

Management Recommendations

1. Develop a fishery management plan for the river.

2. Initiate an angler use survey on the river.

3. Continue the cooperative annual sturgeon monitoring.

4. Develop additional public access above Douglas Reservoir.

5. Develop a musky stocking program (in progress) upstream of Douglas Reservoir.

Nolichucky River

Introduction

The Nolichucky River represents an important recreational resource for the state both in consumptive and non-consumptive uses. It provides critical habitat for species of special concern and is home to approximately 50 species of fish and has historically supported at least 21 species of mussels (Ahlstedt 1986). Additionally, it supports one of east Tennessee's better warmwater sport fisheries. The Nolichucky River and its tributaries have been the subject of numerous biological and chemical investigations that span some 40 years. These investigations have concentrated on evaluating pollution levels and documenting sources for mitigation. Much of the upper reach of the Nolichucky River has been consistently impacted by sand dredging and mica mining in North Carolina and extensive agricultural development along the entire length in Tennessee. However, in recent years, the Nolichucky River has improved in water quality as a result of mitigation and education conducted during these early studies. The Agency has made limited surveys of the river that focused primarily on collecting basic fish, benthic, and water quality data (Bivens 1988). Extensive sport fish population surveys were conducted in 1998 (Carter et al. 1999) from the North Carolina state line to the French Broad River. Our 2009 survey of the Nolichucky was an attempt to locate muskellunge in the river and try to establish areas that data could be collected on this species.

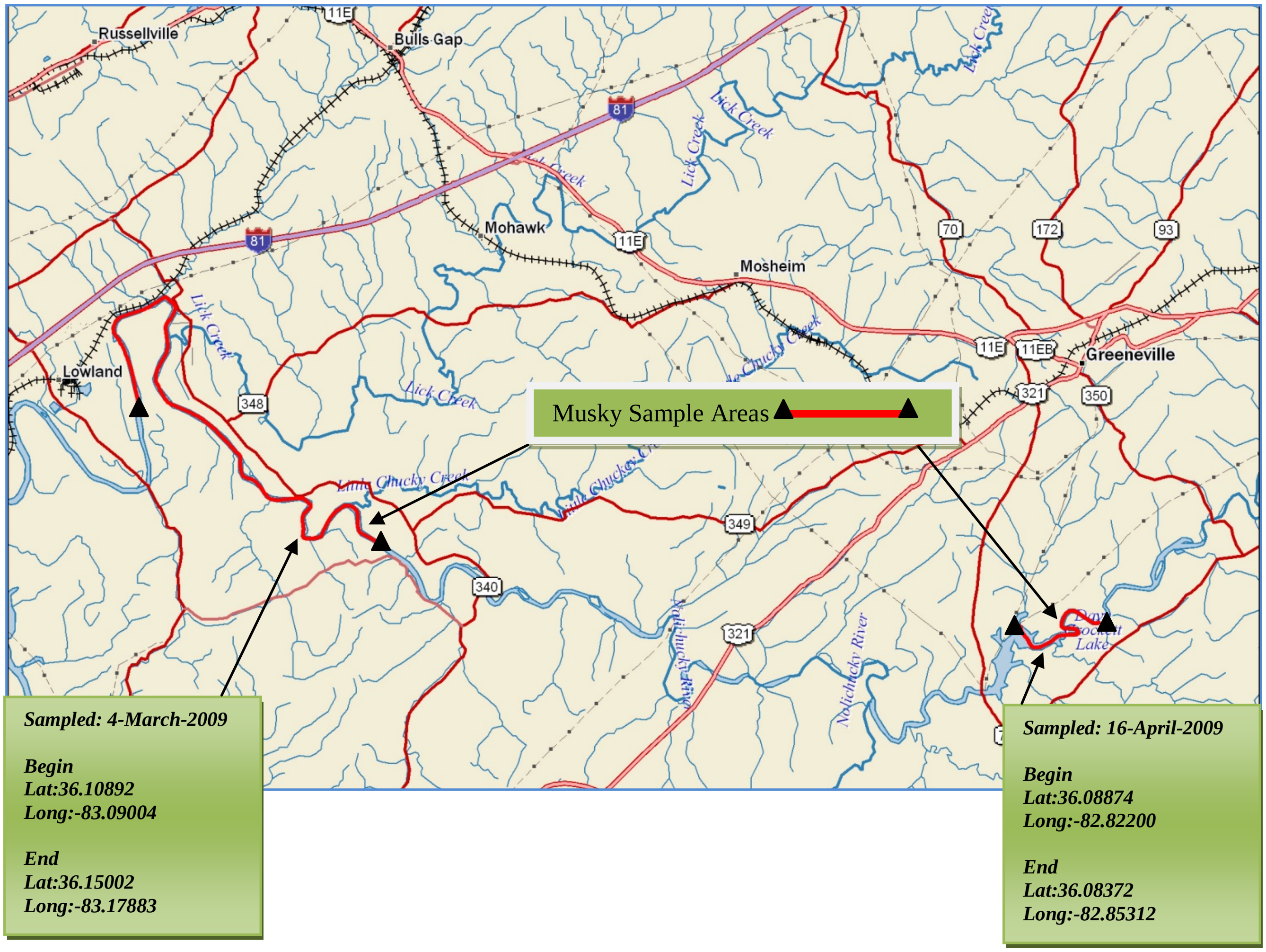
Study Area and Methods

The Nolichucky River originates in North Carolina and flows in a southwesterly direction before emptying into the French Broad River near river mile 69.0. The river has a drainage area of approximately 2,827 kilometers^2. In Tennessee, approximately 159 kilometers of the Nolichucky River flows through the Blue Ridge and Ridge and Valley provinces of east Tennessee, coursing through or by the towns of Erwin, Greeneville, and Morristown before joining the French Broad River near the community of White Pine.

Public access (found in Unicoi, Washington, Greene, Cocke, and Hamblen counties) along the river is primarily limited to bridge crossings and small "pull-outs" along roads paralleling the river. There are several primitive launching areas for canoes or small boats and five developed launching areas managed by the Tennessee Wildlife Resources Agency (Easterly Bridge, Birds Bridge, and Davy Crocket State Park), the City of Greeneville (Kinser Park), and the U.S. Forest Service (Chestoa).

Between March 4 and April 16, 2009, we conducted musky surveys from river mile 12 to 25 (March 4) and from river mile 47.5 to 50.5 (April 16) (Figure 28).

Figure 28. Sample areas for 2009 muskellunge surveys.



Results

We surveyed selected habitat in approximately 12 miles of river during our March effort. A total of 1.75 hours of electrofishing (day time) was conducted during this survey. In the April survey, we focused our efforts upstream of Davy Crockett Dam in Davy Crockett Reservoir which is a small 320 ha impoundment on the Nolichucky River. A total of 1.2 hours of electrofishing effort (night time) was expended along the three river mile survey area. During both surveys we concentrated our efforts on likely habitat (tree tops, heavy shoreline cover, creek mouths) that potentially harbored musky.

Although we surveyed several reaches of the river that looked promising, we did not collect any musky during either survey. In an unrelated survey in February 2009, we did collect one musky (about 660 mm in length) in the headwaters of Douglas Reservoir. This fish most likely originated from a 2006 stocking in the Nolichucky River or from stockings in the French Broad by North Carolina.

Discussion

Musky releases in the Nolichucky have been very sporadic over the last 20 years with approximately 3,300 fish stocked between 1988 and 2006. In 2009, we were able to receive surplus musky from North Carolina Wildlife Resources Commission and the Indiana Department of Natural Resources for the Nolichucky. Approximately 325 Ohio strain musky (mean TL 104 mm) from Table Rock Hatchery in North Carolina were stocked in July 2009. Most were stocked above Davy Crockett Dam with one small release occurring immediately below the dam. In August 2009, we received about 4,260 mixed strain musky (mean TL 151 mm) from the Indiana Department of Natural Resource's East Fork Hatchery that were released between river mile 10.2 and 50.3. Although both groups of fish were not the optimal size for release, we are hopeful that a small percentage will recruit. We will continue to pursue out sources of musky for release into the Nolichucky as TWRA currently does not have a musky production program.

Management Recommendations

1. Continue to develop monitoring strategies for muskellunge in the Nolichucky River.

2. Continue to seek out sources for musky fingerlings for stocking efforts.

3. Assist with the development of a TWRA muskellunge propagation program.

Pigeon River

Introduction

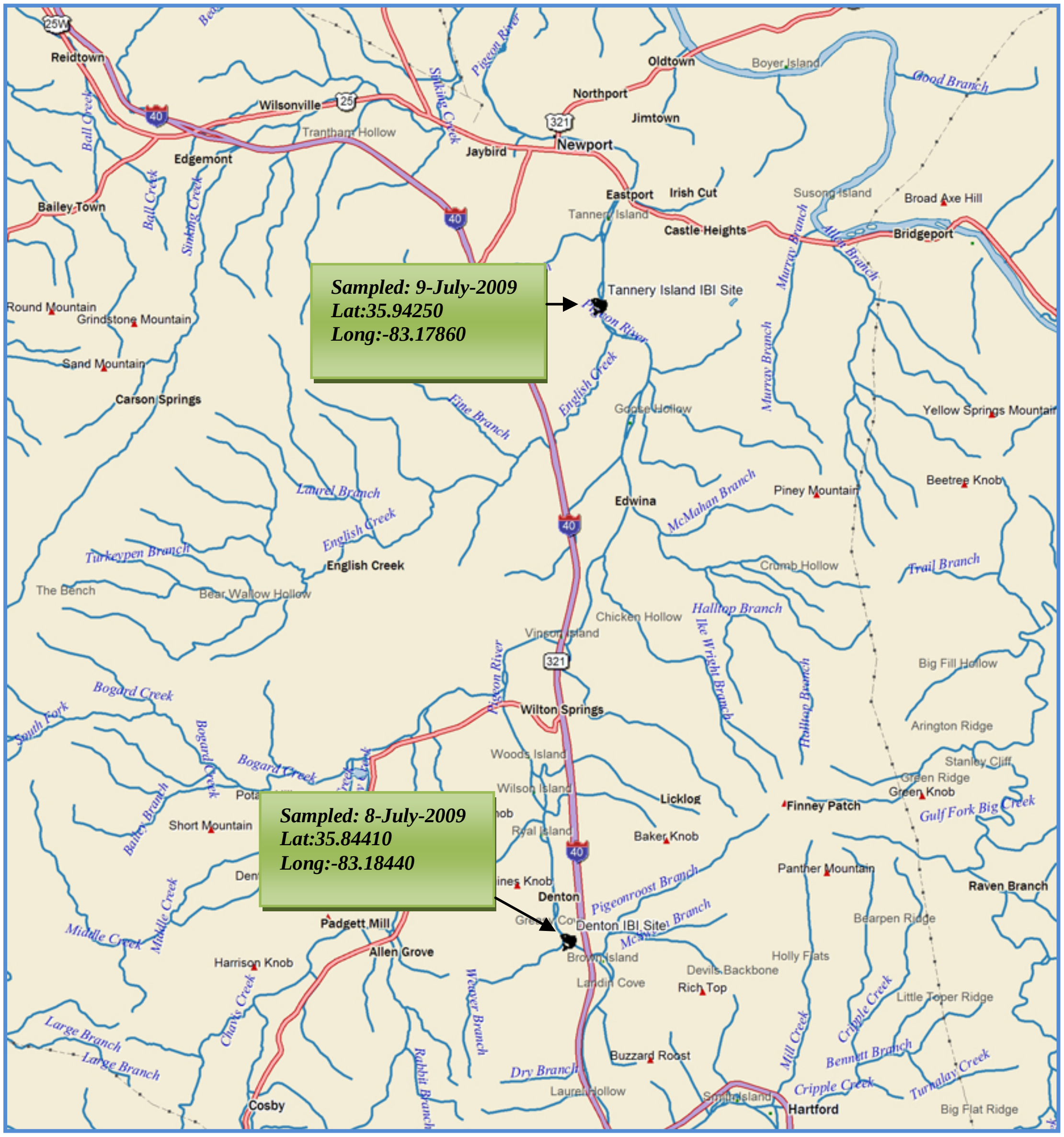
The Pigeon River has had a long history of pollution problems, stemming primarily from the 80 plus-year discharge of wastewater from the Champion Paper Mill in Canton, North Carolina. This discharge has undoubtedly had a profound effect on the recreational use of the river and after the discovery of elevated dioxin levels in the 1980's raised concerns about public health (TDEC 1996). Although the river has received increased attention in recent years, the recreational use of the river has not developed its full potential. In terms of the fishery, consumption of all fish was prohibited up until 1996 when the ordinance was downgraded, limiting consumption of carp, catfish, and redbreast sunfish (TDEC 1996). In 2003, all consumption advisories were removed from the river. Since 1988, inter-agency Index of Biotic Integrity samples have been conducted at two localities, one near river mile 8.2 (Tannery Island) and one at river mile 16.6 (Denton).

Our 2009 surveys focused on continuing to evaluate the fish community at two long-term IBI stations. Catch effort data along with otolith samples from rock bass and black bass were collected from three sites in 1997 (Bivens et al. 1998) and five sites in 1998 (Carter et al. 1999). Since 1999, data has been collected at five to six sites between river mile 4.0 and 20.5. During 1998, a 508 mm minimum (20-inch) length limit on smallmouth bass with a one fish possession limit was passed by the Tennessee Wildlife Resources Commission (TWRC). This regulation was implemented on March 1, 1999.

Study Area and Methods

The Pigeon River originates in North Carolina and flows in a northwesterly direction before emptying into the French Broad River near river mile 73.8. The river has a drainage area of approximately 1,784 km^2 at its confluence with the French Broad River. In Tennessee, approximately 35 kilometers of the Pigeon River flows through mountainous terrain with interspersed communities and small farms before joining the French Broad River near Newport. Public access along the river is primarily limited to bridge crossings and small "pull-outs" along roads paralleling the river. There are a few primitive launching areas for canoes or small boats and one moderately developed launch at Denton. On July 8 and 9, 2009, we conducted IBI fish surveys at Tannery Island (PRM 8.2) and Denton (PRM 16.6) (Figure 29).

Figure 29. Site locations for the IBI samples conducted in the Pigeon River during 2009.



Fish were collected according to the IBI criteria described in the methods section of this report. Both backpack and boat electrofishing were used to collect samples from both stations. Qualitative benthic macroinvertebrates were collected at both stations and analyzed to produce a biotic index score similar to those derived for the fish IBI. Three other benthic collections were made (Waterville, Brown Island and Tannery Island) during March in response to a request from the Environmental Services Division in Nashville.

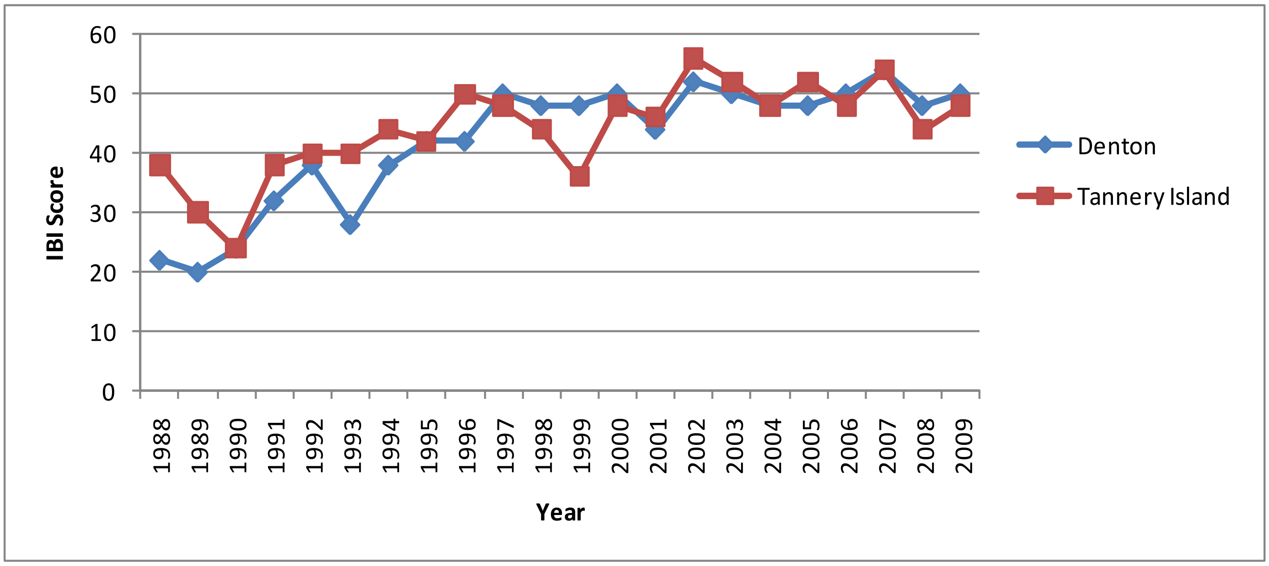
Results

Collaborative community assessments of Pigeon River have been ongoing since the late 1980's. These surveys have primarily focused on evaluating relative health changes in the fish community. A total of 40 fish species were collected at the Tannery Island site while 32 were observed at Denton (Table 8). Overall, The IBI analysis indicated the fish community was in good condition at Tannery Island (IBI score 48). This was a four point improvement over the 2008 score. The condition of the fish community assessed slightly higher at the Denton site scoring 50 (Good), which was two points higher than the previous year (Figure 30).

Table 8. Fish species collected at the two Pigeon River IBI stations during 2009.

Pigeon River Mile	8.2 (Tannery Island)	Number Collected	16.6 (Denton)	Number Collected
	420091401		420091403	
	Ambloplites rupestris	4	*Ambloplites rupestris*	32
	Ameiurus natalis	1	*Ameiurus natalis*	2
	Campostoma oligolepis	44	*Aplodinotus grunniens*	2
	Carpiodes carpio	1	*Campostoma oligolepis*	162
	Cottus carolinae	55	*Cottus carolinae*	103
	Cyprinella galactura	73	*Cyprinella galactura*	171
	Cyprinella spiloptera	58	*Dorosoma cepedianum*	54
	Dorosoma cepedianum	69	*Etheostoma blennioides*	19
	Dorosoma petenense	1	*Etheostoma rufilineatum*	258
	Etheostoma blennioides	91	*Etheostoma tennesseense*	33
	Etheostoma kennicotti	7	*Etheostoma swannanoa*	1
	Etheostoma rufilineatum	603	*Hybopsis amblops*	7
	Etheostoma tennesseense	35	*Hypentelium nigricans*	40
	Etheostoma zonale	1	*Ichthyomyzon castaneus*	2
	Gambusia affinis	3	*Ichthyomyzon greeleyi*	11
	Hybopsis amblops	18	*Ictalurus punctatus*	2
	Hybrid *Lepomis* spp.	1	*Lepomis auritus*	25
	Hypentelium nigricans	10	*Luxilus coccogenis*	1
	Ichthyomyzon sp.	3	*Micropterus dolomieu*	61
	Ictalurus punctatus	4	*Moxostoma anisurum*	1
	Ictiobus bubalus	4	*Moxostoma breviceps*	2
	Ictiobus niger	5	*Moxostoma carinatum*	1
	Lepomis auritus	87	*Moxostoma duquesnei*	18
	Lepomis macrochirus	8	*Moxostoma erythrurum*	6
	Micropterus dolomieu	8	*Notropis leuciodus*	1
	Micropterus salmoides	1	*Notropis micropteryx*	1
	Moxostoma anisurum	2	*Notropis photogenis*	1
	Moxostoma breviceps	5	*Notropis telescopus*	34
	Moxostoma carinatum	2	*Percina caprodes*	1
	Moxostoma duquesneii	35	*Pomoxis annularis*	1
	Moxostoma erythrurum	19	*Rhinichthys cataractae*	1
	Nocomis micropogon	1	*Sander vitreum*	7
	Notropis micropteryx	132		
	Notropis photogenis	30		
	Notropis telescopes	1		
	Notropis volucellus	5		
	Noturus eleutherus	1		
	Percina caprodes	21		
	Percina evides	1		
	Pylodictis olivaris	1		
	Sander vitreum	3		

Figure 30. Trends in Index of Biotic Integrity (IBI) at two stations on the Pigeon River (1988-2009).



Benthic macroinvertebrates collected at the Tannery Island site comprised 31 families representing 37 identified genera (Table 9). The most abundant group in our collection was the caddisflies comprising 36.6% of the total sample. Overall, a total of 46 taxa were identified from the sample of which 13 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "Fair/Good" (3.0).

Table 9 . Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Pigeon River at Tannery Island (river mile 8.2) July, 2009.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				6.44
	Hirudinea		2	
	Oligochaeta		30	
COLEOPTERA				1.61
	Elmidae	*Ancyronyx variegatus*	2	
		Dubiraphia	1	
		Macronychus glabratus	1	
		Microcylloepus pusillus	2	
	Gyrinidae	*Dineutus* larva	1	
	Hydrophilidae	*Tropisternus natator*	1	
DECAPODA				1.61
	Cambaridae	*Orconectes forceps* female juvenile	1	
		Orconectes virilis juveniles	7	
DIPTERA				14.49
	Chironomidae		46	
	Simuliidae		12	
	Tipulidae	*Antocha*	12	
		Tipula	2	
EPHEMEROPTERA				15.49
	Baetidae	*Acentrella*	21	
		Baetis	13	
	Heptageniidae	*Maccaffertium ithaca*	1	
		Maccaffertium mediopunctatum	14	
	Isonychiidae	*Isonychia*	28	
GASTROPODA				6.44
	Ancylidae	*Ferrissia*	8	
	Physidae		11	
	Planorbidae		6	
	Pleuroceridae	*Leptoxis*	4	
		Pleurocera	3	

Table 9. Continued.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
HETEROPTERA	Veliidae	*Rhagovelia obesa*	1	
HYDRACARINA			1	0.20
ISOPODA				1.61
	Caecidotea	*Asellus*	8	
MEGALOPTERA				6.24
	Corydalidae	*Corydalus cornutus*	31	
ODONATA				6.64
	Aeshnidae	*Basiaeshna janata*	1	
		Boyeria vinosa	10	
	Coenagrionidae	*Argia*	6	
		Enallagma	7	
	Corduliidae	*Epicordulia princeps*	1	
		Neurocordulia obsoleta	1	
	Gomphidae	*Dromogomphus spinosus*	1	
		Hagenius brevistylus	4	
	Macromiidae	*Macromia*	2	
PELECYPODA				2.21
	Corbiclidae	*Corbicula fluminea*	11	
PLECOPTERA				0.20
	Perlidae	*Perlesta* freckled form	1	
TRICHOPTERA				36.62
	Hydropsychidae	*Ceratopsyche morosa*	118	
		Cheumatopsyche	47	
		Hydropsyche franclemonti	1	
	Hydropsychidae pupae		10	
	Hydroptilidae	*Hydroptila* larva and pupa	2	
	Leptoceridae	*Oecetis*	2	
		Triaenodes ignitus	1	
	Polycentropodidae	*Neuroclipsis crepuscularis*	1	
		Total	497	

TAXA RICHNESS = 46 EPT TAXA RICHNESS = 13 BIOCLASSIFICATION = FAIR/GOOD (3.0)

Benthic macroinvertebrates collected at the Denton site comprised 37 families representing 41 identified genera (Table 10). The most abundant group in our collection was the caddisflies comprising 37.1% of the total sample. Overall, a total of 51 taxa were identified from the sample of which 19 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as “Fair/Good” (3.0).

Table 10. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Pigeon River at Denton (river mile 17.1) July, 2009.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA				0.45
	Gammaridae/Crangonyctidae		4	
ANNELIDA				1.91
	Hirudinea		1	
	Oligoghaeta		16	
COLEOPTERA				4.93
	Dryopidae	*Helichus* adults	11	
	Elmidae	*Dubiraphia* adult	1	
		Macronychus glabratus larvae and adults	9	
		Optioservus trivittatus	1	
		Promoresia elegans adults	4	
	Gyrinidae	*Dineutus discolor* adults	6	
		Dineutus larva	2	
		Gyrinus adults	6	
	Haliplidae	*Peltodytes lengi*	1	
	Hydrophilidae	*Cymbiodyta*	2	
	Psephenidae	*Psephenus herricki*	1	
DECAPODA				0.56
	Cambaridae	*Cambarus longirostris*	2	
		Orconectes virilis	3	

Table 10. Continued.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
DIPTERA				11.32
	Chironomidae		67	
	Simuliidae		7	
	Tipulidae	*Antocha*	25	
		Tipula	2	
EPHEMEROPTERA				28.25
	Baetidae	*Acentrella*	35	
		Baetis	24	
	Caenidae	*Caenis*	4	
	Ephemerellida	*Ephemerella/Serratella* early instar	2	
	Heptageniidae	*Maccaffertium*	33	
		Maccaffertium ithaca	6	
		Maccaffertium mediopunctatum	15	
	Isonychiidae	*Isonychia*	133	
GASTROPODA				1.12
	Physidae		2	
	Pleuroceridae	*Leptoxis*	8	
HETEROPTERA				0.45
	Nepidae	*Ranatra nigra*	1	
	Veliidae	*Rhagovelia obesa*	3	
HYDROCARINA			2	0.22
ISOPODA				0.90
	Asellidae	*Caecitotea*	8	
MEGALOPTERA				6.28
	Corydalidae	*Corydalus cornutus*	51	
		Nigronia serricornis	5	
ODONATA				3.48
	Aeshnidae	*Boyeria vinosa*	14	
	Coenagrionidae	*Argia*	5	
	Corduliidae	*Neurocordulia yamakanensis*	1	
	Macromiidae	*Macromia*	11	
PELECYPODA				3.03
	Corbiculidae	*Corbicula fluminea*	27	
TRICHOPTERA				37.11
	Brachycentridae	*Brachycentrus lateralis*	22	
	Hydropsychidae	*Ceratopsyche morosa*	177	
		Ceratopsyche sparna	9	
		Cheumatopsyche	89	
		Hydropsyche franclemonti	5	
		Hydropsyche venularis	1	
		Undertermined pupae	5	
	Hydroptilidae	*Hydroptila*	1	
	Lepidostomatidae	*Lepidostoma*	1	
	Leptoceridae	*Oecetis*	1	
	Polycentropodidae	*Neureclipsis crepuscularis*	2	
		Polycentropus	17	
	Psychomyiidae	*Lype diversa*	1	
		Total	892	

TAXA RICHNESS = 51 EPT TAXA RICHNESS = 19 BIOCLASSIFICATION = FAIR/GOOD (3.0)

In response to a request from TWRA's Environmental Services Division in Nashville, we conducted three additional benthic surveys in March 2009. This was done to characterize the benthic community diversity and composition during this time of year. Our surveys were located below the powerhouse at Waterville, Brown Island at Denton, and Tannery Island near Newport. Aquatic insects were collected from habitats represented at each site for a total of 3 effort hours. Samples were identified to the lowest taxanomic level and summarized. Biotic index scores were also generated to determine the relative health of the benthic community.

Benthic macroinvertebrates collected at the Waterville site comprised 29 families representing 30 identified genera (Table 11). The most abundant group in our collection was the dipterans (true flies) comprising 38% of the total sample. Overall, a total of 41 taxa were identified from the sample of which 26 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as "Good" (4.5).

Table 11. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Pigeon River at Waterville (river mile 24.7) March, 2009.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA				0.7
	Crangonyctidae		5	
ANNELIDA				2.6
	Oligochaeta		18	
COLEOPTERA				0.1
	Hydraenidae	*Hydraena* adult	1	
DIPTERA				38.0
	Chironomidae		252	
	Simuliidae		6	
	Tipulidae	*Antocha*	2	
EPHEMEROPTERA				23.5
	Baetidae	*Baetis*	1	
	Ephemerellidae	*Ephemerella rotunda*	99	
		Ephemerella sp.	2	
		Eurylophella	2	
	Heptageniidae	*Epeorus pluralis*	27	
		Epeorus rubidus/subpallidus	2	
		Maccaffertium ithaca	7	
	Isonychiidae	*Isonychia*	13	
	Leptophlebiidae	*Paraleptophlebia*	8	
GASTROPODA				0.3
	Ancylidae	*Ferrissia*	1	
	Physidae		1	
HYDRACARINA			1	0.1
ISOPODA				0.6
	Asellidae	*Caecidotea*	4	
MEGALOPTERA				1.2
	Corydalidae	*Corydalus cornutus*	3	
		Nigronia serricornis	4	
	Sialidae	*Sialis*	1	
ODONATA				0.1
	Aeshnidae	*Boyeria vinosa*	1	
PELECYPODA				2.3
	Corbiculidae	*Corbicula fluminea*	16	
PLECOPTERA				7.7
	Leuctridae	*Leuctra*	1	
	Peltoperlidae	*Peltoperla*	3	
	Perlidae	*Acroneuria abnormis*	11	
	Perlodidae	*Cultus*	2	
		Isoperla cotta/orata early instars	2	
		Isoperla namata	34	
TRICHOPTERA				22.6
	Glossosomatidae	*Glossosoma* pupae	4	
	Hydropsychidae	*Ceratopsyche morosa*	18	
		Ceratopsyche sparna	16	
		Cheumatopsyche	28	
		Hydropsyche franclemonti	1	
		Hydropsyche venularis	9	
	Hydroptlidae	*Leucotrichia pictipes*	12	
	Lepidostomatidae	*Lepidostoma*	50	
	Philopotamidae	*Dolophilodes distinctus*	1	
	Poyocentropodidae	*Polycentropus*	2	
	Uenoidae	*Neophylax consimilis*	14	
		Total	**685**	

TAXA RICHNESS = 41 EPT TAXA RICHNESS = 26 BIOCLASSIFICATION = GOOD (4.5)

Benthic macroinvertebrates collected at the Brown Island site comprised 26 families representing 29 identified genera (Table 12). The most abundant group in our collection was the mayflies comprising 34.6% of the total sample.

Overall, a total of 36 taxa were identified from the sample of which 23 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as “Good” (4.3).

Table 12. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Pigeon River at Denton (river mile 17.1) March, 2009.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA				0.4
	Crangonyctidae	*Crangonyx/Synurella*	3	
ANNELIDA				0.9
	Oligochaeta		6	
DIPTERA				28.1
	Chironomidae		178	
	Simuliidae		4	
	Tipulidae	*Antocha*	6	
EPHEMEROPTERA				34.6
	Ameletidae	*Ameletus lineatus*	4	
	Baetidae	*Baetis*	1	
	Ephemerellidae	*Ephemerella needhami*	13	
		Ephemerella rotunda	25	
		Eurylophella	3	
	Heptageniidae	*Cinygmula subaequalis*	1	
		Epeorus pleuralis	2	
		Maccaffertium mediopunctatum	26	
		Maccaffertium modestum	2	
	Isonychiidae	*Isonychia*	151	
	Leptophlebiidae	*Leptophlebia*	3	
GASTROPODA				0.1
	Pleuroceridae	*Leptoxis* relic	1	
HYDRACARINA			1	0.1
ISOPODA				2.2
	Asellidae	*Caecidotea*	15	
MEGALOPTERA				2.4
	Corydalidae	*Corydalus cornutus*	15	
		Nigronia serricornis	1	
ODONATA				1.0
	Aeshnidae	*Boyeria vinosa*	5	
	Coenagrionidae	*Argia*	1	
	Gomphidae	*Gomphus lividus*	1	
PELECYPODA				1.2
	Corbiculidae	*Corbicula fluminea*	8	
PLECOPTERA				1.3
	Perlidae	*Acroneuria abnormis*	6	
	Taeniopterygidae	*Taenionema atlanticum*	1	
		Taeniopteryx prob. *burksi*	2	
TRICHOPTERA				27.4
	Brachycentridae	*Brachycentrus lateralis*	3	
	Glossosomatidae	*Glossosoma nigrior*	1	
	Hydropsychidae	*Ceratopsyche morosa*	58	
		Ceratopsyche sparna	10	
		Cheumatopsyche	96	
		Hydropsyche venularis	8	
	Lepidostomatidae	*Lepidostoma*	4	
	Philopotamidae	*Chimara*	1	
	Polycentropodidae	*Polycentropus*	2	
		Total	**668**	

TAXA RICHNESS = 36   EPT TAXA RICHNESS = 23   BIOCLASSIFICATION = GOOD (4.3)

Benthic macroinvertebrates collected at the Tannery Island site comprised 26 families representing 24 identified genera (Table 13). The most abundant group in our collection was the mayflies comprising 49.7% of the total sample. Overall, a total of 37 taxa were identified from the sample of which 16 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as “Good” (4.0).

Table 13. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from the Pigeon River at Tannery Island (river mile 8.2) March, 2009.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
AMPHIPODA				0.4
	Crangonyctidae		3	
ANNELIDA				1.1
	Hirudinea		3	
	Oligochaeta		5	
COLEOPTERA				0.9
	Dytiscidae	*Neoporus shermani*	4	
	Elmidae	*Ancyronyx varigatus*	1	
		Macronychus glabratus	1	
DIPTERA				26.0
	Chironomidae		145	
	Empididae		1	
	Simuliidae		30	
	Tipulidae	*Antocha*	4	
		Tipula	3	
EPHEMEROPTERA				49.7
	Baetidae	*Baetis*	1	
	Ephemerellidae	*Ephemerella needhami*	42	
		Ephemerella rotunda	80	
		Ephemerella septentrionalis	2	
		Eurylophella	1	
	Heptageniidae	*Maccaffertium* early instars	8	
		Maccaffertium mediopunctatum	25	
		Maccaffertium modestum	9	
		Maccaffertium vicarium	2	
	Isonychiidae	*Isonychia*	179	
	Leptophlebiidae	*Leptophlebia*	1	
GASTROPODA				4.4
	Ancylidae	*Ferrissia*	6	
	Lymnaeidae		1	
	Physidae		4	
	Pleuroceridae	*Leptoxis*	6	
		Pleurocera	14	
ISOPODA				1.1
	Asellidae	*Caecidotea*	8	
MEGALOPTERA				2.1
	Corydalidae	*Corydalus cornutus*	15	
ODONATA				0.6
	Coenagrionidae	*Argia*	2	
		Enallagma	2	
PELECYPODA				0.6
	Corbiculidae	*Corbicula fluminea*	4	
PLECOPTERA				0.1
	Nemouridae	*Amphinemura*	1	
TRICHOPTERA				12.9
	Brachycentridae	*Brachycentrus lateralis*	5	
	Hydropsychidae	*Ceratopsyche morosa*	31	
		Ceratopsyche sparna	1	
		Cheumatopsyche	52	
	Hydroptilidae	*Leucotrichia pictipes*	2	
		Total	**704**	

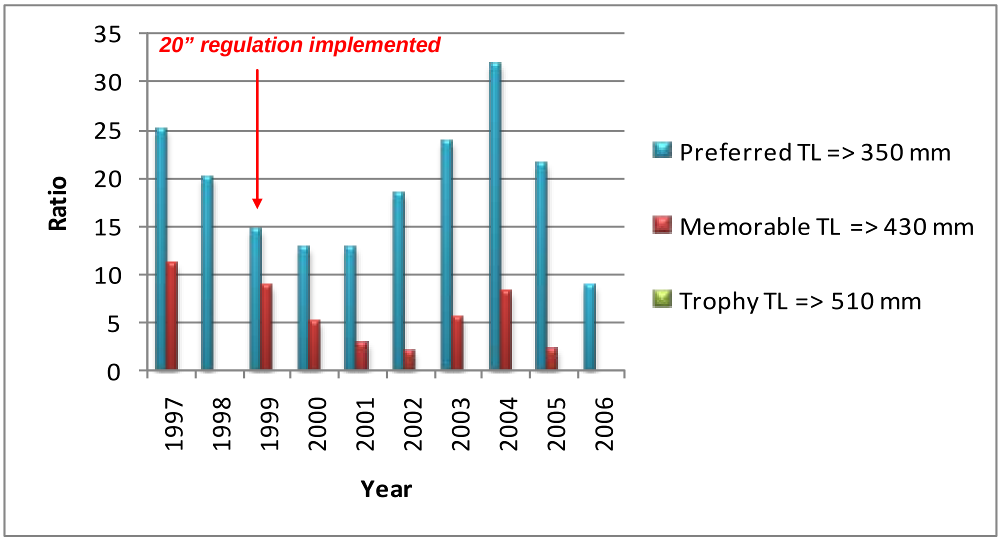
TAXA RICHNESS = 37 EPT TAXA RICHNESS = 16 BIOCLASSIFICATION = GOOD (4.0)

Discussion

The Pigeon River provides anglers with the opportunity to catch all species of black bass as well as rock bass. Perhaps the greatest potential for elevating this river's "trophy" status lies in the smallmouth bass population. The last black bass and rock bass survey of the Pigeon was in 2006. The river was put into a rotational survey scheme after 2006 and was scheduled to be sampled in 2009. Unfortunately, excessive generation from the Waterville Powerhouse precluded us from sampling during September or October. We will attempt to sample the bass population in 2010 providing we have adequate flows.

During 2006, we recorded the lowest percentage of preferred smallmouth bass to date (Figure 31). Overall, the value decreased 59% from the previous year and was 53% lower than the ten year average. There was no memorable size bass collected in 2006, which only occurred in one other instance (1998) during the ten year time period.

Figure 31. Trends in the ratio of preferred, memorable, and trophy smallmouth bass collected from the Pigeon River 1997-2006.



Water quality improvement over the last 20 years has primarily been the result of more advanced wastewater treatment at the Blue Ridge Paper Mill in Canton, North Carolina. The improved water quality has undoubtedly had an effect on the amount of recreation that is currently taking place, particularly whitewater rafting. It has also resulted in the return of a few species (e.g. silver shiner, telescope shiner) previously not encountered in the annual surveys and the implementation of a fish and mollusk recovery effort. During 2006, there were at least two instances of pesticides entering the river. During these events, both benthic invertebrates and fish were killed. Investigations by TWRA and TDEC resulted in identifying the areas of agricultural runoff into the river. A remediation plan to control the runoff of agricultural pesticides is being developed by TDEC and TWRA.

In December 2009, 41,793 fingerling rainbow trout were fin clipped at TWRA's Buffalo Springs Hatchery. These trout were released into the Pigeon River later that month between Walters Powerhouse and Bluffton. The objective of this experimental release is to evaluate the potential for establishing a trout fishery managed with fingerling stockings. We will evaluate the release in 2010 to determine trout distribution and survival in the river. We are hopeful that a fishery can be established in the upper reach of the river based on the persistence of wild trout in this section of the river.

We will monitor black bass and rock bass populations in the Pigeon River during late September or October in order to maintain our efficiency in characterizing the smallmouth bass populations in the river. Index of Biotic Integrity samples will continue on an annual basis.

Management Recommendations

1. Continue monitoring the sport fish population every three years.

2. Continue the cooperative IBI surveys at the two established stations (Denton and Tannery Island).

3. Develop a management plan for the river.

4. Continue cooperative efforts to reintroduce common species.

5. Closely monitor black fly control program being conducted by the University of Tennessee.

6. Consider developing a put and take or delayed harvest trout stocking program in the upper reach of the river (mile 16 and above).

Titus Creek

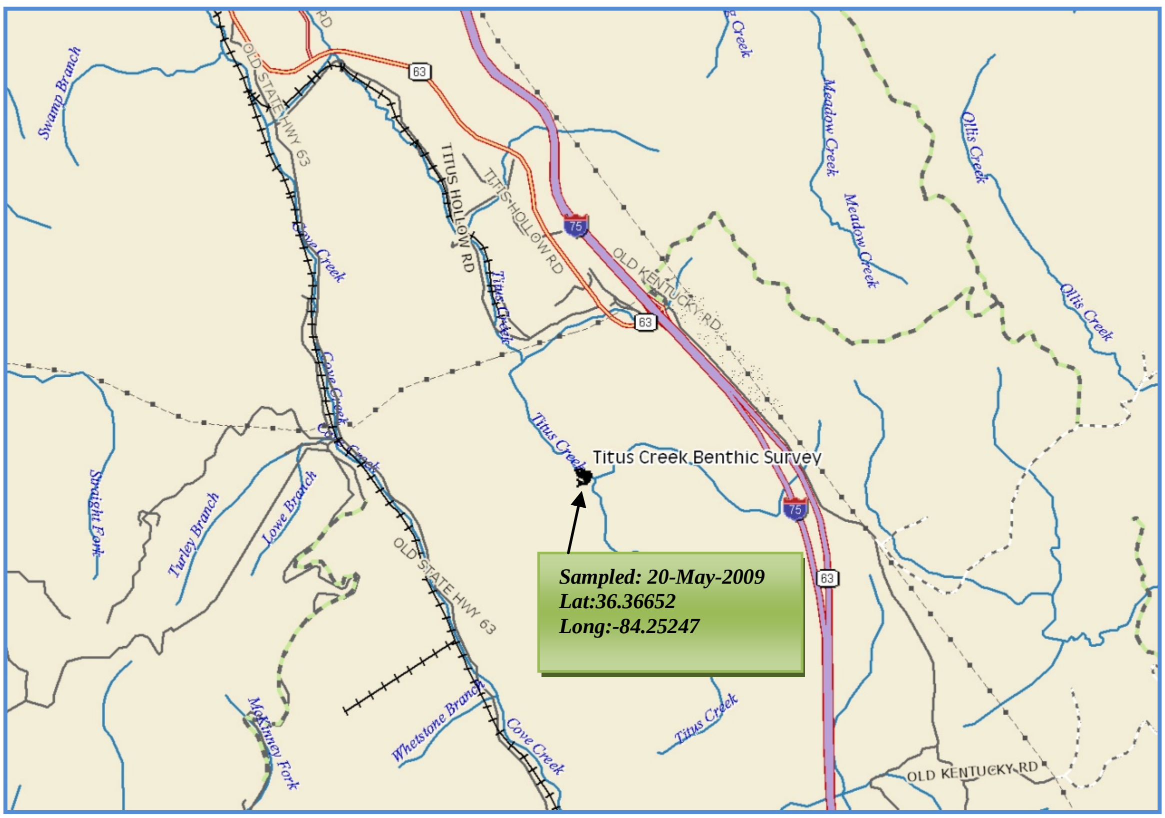
Introduction

The recent invasion of Hemlock Woolly Adelgid (HWA) into the Eastern U.S. has resulted in a unified effort by many natural resource management agencies to develop strategies to manage this exotic insect. Tennessee has been no exception to this effort, creating a HWA taskforce in 2005 to develop a management plan for the state's forest resources. This insect, when established in sufficient densities, attack hemlocks ultimately killing trees in a stand or the whole stand depending on the infestation level.

Study Area and Methods

In the spring of 2009 we were asked by TWRA's Forestry Division and the U.S. Forest Service to conduct a benthic macroinvertebrate survey of Titus Creek. Specifically the request wanted us to characterize benthic community before the release of an insect killing fungus targeted at controlling HWA in an experimental stand of hemlocks. On May 20, 2009 we selected an area on Titus Creek to survey that would capture the area subjected to the aerial spraying of the fungal agent Mycotal (Figure 32).

Figure 32. Site location for the benthic survey of Titus Creek conducted in 2009.



The stream at this location averaged about 3 meters in width and had a low to moderate grade. There was a prevalence of sand and bedrock in the sample. Cobbles were fairly abundant with gravels being the least abundant substrate component in our sample area. Riffles were infrequent, but where they did occur, provided adequate habitat for collecting benthic organisms.

Results

We collected aquatic insects from Titus Creek during a combined three hour effort. Benthic macroinvertebrates collected at the site comprised 31 families representing 37 identified genera (Table 14). The most abundant group in our collection was the mayflies comprising 22.2% of the total sample. Overall, a total of 46 taxa were identified from the sample of which 27 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as “good” (4.5).

Table 14. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Titus Creek May 2009.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
ANNELIDA				2.6
	Branchiobdellida		3	
	Oligochaeta		2	
COLEOPTERA				9.8
	Dryopidae	*Helichus* adults	16	
	Elmidae	*Optoservus ovalis* adult	1	
		Stenelmis adults	2	
DIPTERA				17.0
	Ceratopogonidae	*Palpomyia* complex	1	
	Chironomidae	larvae	15	
	Simuliidae	larvae	6	
	Tipulidae	*Hexatoma*	2	
		Pilaria	2	
		Tipula	7	
EPHEMEROPTERA				22.2
	Baetidae	*Baetis*	18	
	Ephemerellidae	*Ephemerella*	1	
		Eurylophella	8	
	Ephemeridae	*Ephemera*	1	
	Heptageniidae	*Heptagenia*	9	
		Maccaffertium vicarium	2	
		Stenacron interpunctatum	2	
	Leptophlebiida	*Habrophlebia vibrans*	1	
		Habrophlebiodes	1	
HETEROPTERA				2.6
	Gerridae	*Aquarius remigis* males and females	5	

Table 14. Continued.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
MEGALOPTERA				3.6
	Corydalidae	*Nigronia serricornis*	6	
	Sialidae	*Sialis*	1	
ODONATA				2.6
	Calopterygidae	*Calopteryx maculata*	1	
	Cordulegastridae	*Cordulegaster maculata*	1	
	Corduliidae	*Helocordulia uhleri*	2	
	Gomphidae	*Gomphus rogersi*	1	
PLECOPTERA				20.1
	Leuctridae	*Leuctra*	4	
	Nemouridae	*Amphinemura delosa/nigritta*	6	
	Perlidae	*Acroneuria abnormis*	7	
		Eccoptura xanthenes	5	
	Perlodidae	*Isoperla holochlora*	5	
		Isoperla transmarina	8	
		Isoperla undetermined	2	
		Remenus bilobatus	2	
PELECYPODA				0.5
	Sphaeriidae	*Sphaerium*	1	
TRICHOPTERA				19.1
	Hydropsychidae	*Cheumatopsyche* pupa	1	
		Diplectrona modesta	1	
	Lepidostomatidae	*Lepidotoma*	3	
	Limnephilidae	*Pycnopsyche gentilis*	1	
		Pycnopsyche guttifer/scabripennis group	1	
		Pycnopsyche luculenta group	14	
	Polycentropodidae	*Polycentropus*	2	
	Rhyacophilidae	*Rhyacophila* larva and pupa	2	
	Uenoidae	*Neophylax aniqua*	9	
		Neophylax concinnus	1	
		Neophylax wigginsi	2	
		Total	**194**	

TAXA RICHNESS = 46   EPT TAXA RICHNESS = 27   BIOCLASSIFICATION = GOOD (4.5)

Our assessment of the stream quality resulted in a score of 37 (poor). This score was primarily influenced by the relatively poor substrate composition of the stream. Additionally, a crayfish survey was done in a wetland area adjacent to Titus Creek to verify the occurrence of the crayfish *Cambarus dubius*. Pipe trap and mist net sets allowed us to collect one female crayfish (Cat. 1490).

Discussion

We will be returning to Titus Creek in 2010 to re-sample the site in order to assess any changes in the benthic community diversity and/or abundance as a result of the treatment. Future application of the fungus should require similar assessments if the application has the potential to enter stream systems.

Management Recommendations

1. Conduct follow-up surveys of the benthic community to assess any impacts from the Mycotal application.

Poplar Creek

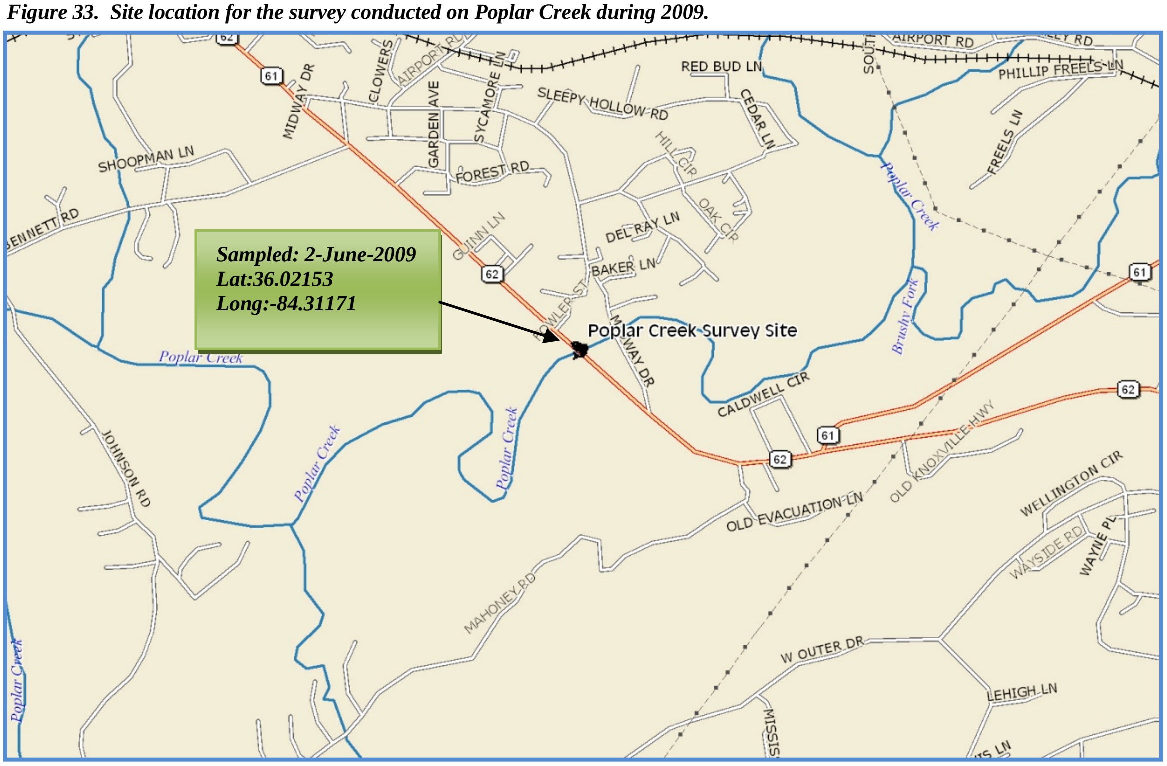
Introduction

Poplar Creek was sampled to evaluate the relative health of the stream and to develop fish and aquatic insect lists for TADS. Poplar Creek and its tributaries have had a long history of pollution related problems stemming from industrial, governmental, and residential development in and around the City of Oak Ridge. The Agency has made no fish collections from this stream, but was asked by the Tennessee Department of Transportation (TDOT) in 2007 to conduct a survey for the state listed crayfish *Cambarus deweesae*. This survey was completed as part of a bridge replacement assessment being administered by TDOT.

Study Area and Methods

Our survey of Poplar Creek was located at the bridge crossing on Highway 62 and was conducted on June 2, 2009 (Figure 33). One Index of Biotic Integrity (IBI) survey was conducted in order to assess the relative health of the stream. We surveyed about 500 meters upstream of the bridge crossing in order to fulfill the depletion requirements of the IBI. The stream at this location was low grade and had substrate composition of primarily sand, gravel and cobble in the riffle areas and silt, sand and gravel in the pools. In stream habitat was predominately pool habitat, comprising about 90% of the habitat features in our sample area. Woody cover was lacking in the stream and substantial portion of the stream banks within the reach showed signs of instability during periods of high flows. Both riparian zones were intact and well vegetated with shrubs and trees. We used one backpack electrofishing unit in combination with a 20' seine to collect fish. Water quality data from this location indicated a temperature of 21.5 C, a conductivity of 230 µs/cm, and a pH of 6.5.

Figure 33. Site location for the survey conducted on Poplar Creek during 2009.



Results

We collected a total of 281 fish representing 24 species during the sample (Table 15). The two dominant species collected were striped shiner and bluntnose minnow. Together, these two species comprised 52% of the fish collected. Three darter species were collected which included Tennessee darter, blueside darter, and logperch. Two sucker species (northern hog sucker and golden redhorse) were collected here with the northern hog sucker being the most abundant. Game species collected included redbreast sunfish, spotted bass, bluegill, redear sunfish, largemouth bass, and warmouth although most of these were at low abundance.

Table 15. Fish and crayfish species collected from Poplar Creek during 2009.

SPECIES	NUMBER
Campostoma oligolepis	17
Cottus carolinae	1
Cyprinella spiloptera	38
Dorosoma cepedianum	1
Etheostoma jessiae	8
Etheostoma rufilineatum	10
Etheostoma tennesseense	4
Fundulus catenatus	1
Gambusia affinis	1
Hybopsis amblops	3
Hypentelium nigricans	12
Lepisosteus osseus	1
Lepomis auritus	16
Lepomis gulosus	1
Lepomis macrochirus	5
Lepomis macrochirus x Lepomis auritus hybrid	1
Lepomis microlophus	1
Luxilus chrysocephalus	78
Lythrurus fasciolaris	1
Micropterus punctatus	1
Micropterus salmoides	1
Moxostoma erythrurum	2
Percina caprodes	7
Pimephales notatus	69
Semotilus atromaculatus	1
Cambarus sp of *girardinus* (Cat.1488)	3
Orconectes forceps (Cat. 1489)	5

Overall, the IBI analysis indicated Poplar Creek was in poor condition (IBI score = 30). Generally streams in this classification are dominated by omnivores, tolerant forms, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed; hybrids and diseased fish are often present. The most influential metrics on our score were the low number of

Table 16. Poplar Creek Index of Biotic Integrity analysis 2009.

Metric Desciption	Scoring Criteria 1 3 5	Observed	Score
Number of Native Species	<12 12-26 >26	22	3
Number of Darter Species	<3 3-5 >5	4	3
Number of Sunfish Species less *Micropterus sp.*	1 1-2 >2	3	5
Number of Sucker Species	1 1-2 >2	2	3
Number of Intolerant Species	<2 2-4 >4	1	1
Percent of Individuals as Tolerant	>28 28-14 <14	45.2	1
Percent of Individuals as Omnivores	>31 31-16 <16	62.7	1
Percent of Individuals as Specialists	<23 23-47 >47	12.9	1
Percent of Individuals as Piscivores	<2 2-4 >4	1.1	1
Catch Rate	<18 18-38 >38	20.6	3
Percent of Individuals as Hybrids	>1 Trace-1 0	0.4	3
Percent of Individuals with Anomalies	>5 2-5 <2	0.8	5
		Total	**30 (Poor)**

intolerant species, high percentage of tolerant species, low percentage of trophic specialists, the low percentage of piscivores in the sample (Table 16). Physical habitat evaluation indicated that this reach of the stream was in marginal to sub-optimal condition based on a mean score of 114.

Benthic macroinvertebrates collected in Poplar Creek comprised 24 families representing 30 identified genera (Table 17). The most abundant group in our collection was the caddisflies comprising 36.9% of the total sample. Overall, a total of 35 taxa were identified from the sample of which 14 were EPT. Based on the EPT taxa richness and overall biotic index of all species collected, the relative health of the benthic community was classified as “Fair/Good-Good” (3.7).

Table 17. Taxa list and associated biotic statistics for benthic macroinvertebrates collected from Poplar Creek in 2009.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
COLEOPTERA				2.05
	Elmidae	*Dubiraphia* adult	1	
		Stenelmis adults	2	
	Gyrinidae	*Dineutus discolor* female	1	
	Hydrophilidae	*Anacaena limbata* adult	1	
	Psephenidae	*Psephenus herricki* adult	1	
DIPTERA				6.85
	Chironomidae		11	
	Simuliidae		7	
	Tipulidae	*Tipula*	2	

Table 17. Continued.

ORDER	FAMILY	SPECIES	NUMBER	PERCENT
EPHEMEROPTERA				8.90
	Baetidae	*Baetis*	4	
	Ephemerellidae	*Eurylophella*	1	
		Timpanago	1	
	Heptageniidae	*Maccaffertium mediopunctatum*	2	
		Maccaffertium pulchellum	2	
		Stenacron interpunctatum	15	
		Stenonema femoratum	1	
GASTROPODA				7.19
	Pleuroceridae		21	
HETEROPTERA				1.37
	Gerridae	*Aquarius conformis* females	2	
	Veliidae	*Rhagovelia obesa*	2	
ISOPODA				2.40
	Asellidae	*Caecidotea*	5	
		Lirceus	2	
ODONATA				7.53
	Aeshnidae	*Boyeria vinosa*	9	
	Coenagrionidae	*Argia*	4	
		Enallagma	4	
	Gomphidae	*Dromogomphus spinosus*	1	
		Gomphus lividus	1	
		Hagenius brevistylus	2	
	Macromiidae	*Macromia*	1	
PELECYPODA				1.37
	Corbiculidae	*Corbicula fluminea*	4	
PLECOPTERA				25.34
	Nemouridae	*Amphinemura delosa*	2	
	Perlidae	*Perlesta* freckled form	71	
		Perlesta non-freckled form	1	
TRICHOPTERA				36.99
	Hydrophilidae	*Cheumatopsyche*	55	
		Hydrospyche betteni/depravata	49	
	Leptoceridae	*Triaenodes ignitus*	2	
	Philopotamidae	*Chimara*	2	
		Total	292	

TAXA RICHNESS = 35 EPT TAXA RICHNESS = 14 BIOCLASSIFICATION = FAIR/GOOD-GOOD (3.7)

Discussion

As is the case with many streams located in an urban environment, Poplar Creek and its tributaries have been subjected to decades of industrial, commercial, and residential development. This has ultimately led to the physical degradation of the stream and the resulting impairment to the aquatic wildlife in the stream. The presence of four darter species including the intolerant blueside darter was one aspect of the stream that was somewhat encouraging. Given the current land use in the area and the continued development within the watershed, it is not likely that Poplar Creek will ever recover to its full potential.

Management Recommendations

1. Any action that would address non-point source pollution within the watershed would be beneficial.

2. The protection of the state listed Valley Flame Crayfish *Cambarus deweesae* is of upmost importance. Wetland habitat at this locale is one of the few places in Tennessee where this species is found.

Indian Creek Wetland

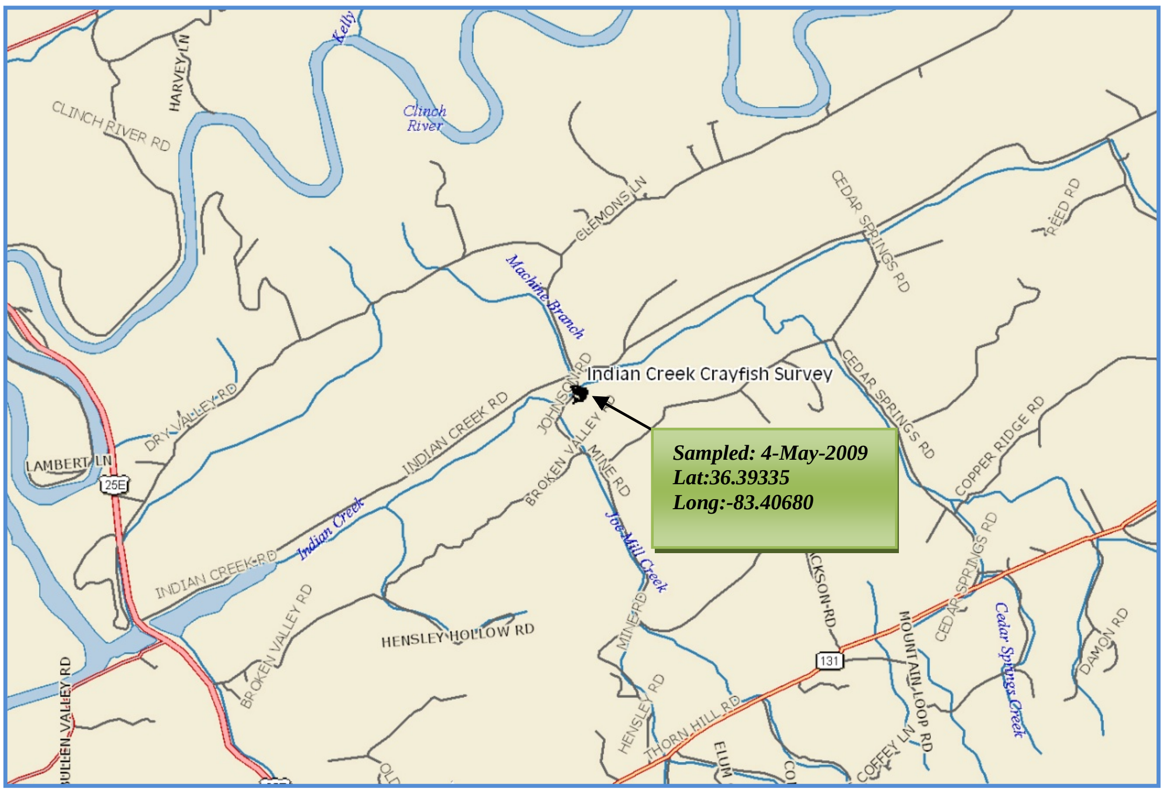
Introduction

The stream survey unit in Region 4 has had a long standing interest in crayfish distribution not only within the region but throughout the state. As a result, documentation of species occurrence and distribution has been made for many areas within the region and to a lesser extent statewide. During 2009, we specifically designed a limited number of crayfish surveys to evaluate the composition of species that were considered primary burrowers within the Clinch and Powell river watersheds.

Study Area and Methods

The Wetland we surveyed was located along Indian Creek upstream from the bridge crossing on Johnson Road (Figure 34). Our survey technique consisted of setting of ten pipe traps (24 hour sets) placed in burrows to collect crayfish.

Figure 34. Sample site location for the crayfish survey conducted along Indian Creek.



Results

Our collection resulted in the capture of two *Cambarus dubius*(Cat. 1491). All specimens were retained and cataloged into TWRA's crayfish collection in Morristown. This represents the first documentation of this species at this location within the watershed.

Discussion

The collection and identification of burrowing crayfish is a relatively new area of investigation that is much needed throughout the state. This collection will aid in completing the distribution for this species and identifying this wetland as a habitat that should be protected from development.

Management Recommendations

1. Any action that would preserve the integrity of this wetland would be of benefit for sustaining this population of crayfish.

Caney Valley

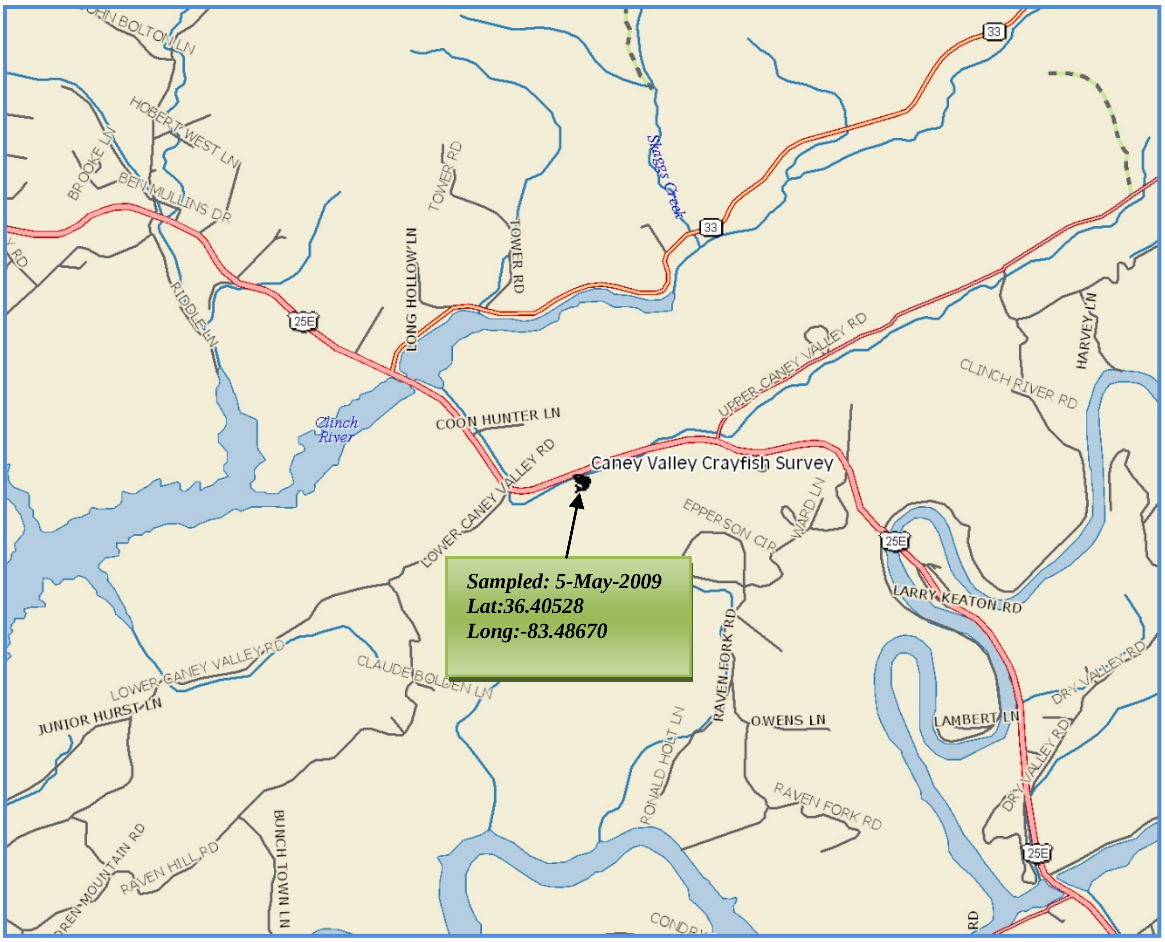
Introduction

The stream survey unit in Region 4 has had a long standing interest in crayfish distribution not only within the region but throughout the state. As a result, documentation of species occurrence and distribution has been made for many areas within the region and to a lesser extent statewide. During 2009, we specifically designed a limited number of crayfish surveys to evaluate the composition of species that were considered primary burrowers within the Clinch and Powell river watersheds.

Study Area and Methods

Caney Valley is an area that runs parallel to the Clinch River in Claiborne County (Figure 35). Our survey site was located in a wetland area adjacent to a seep off of Hwy. 25E behind the Caney Valley American Christian Church. We

Figure 35. Sample site location for the crayfish survey conducted in Caney Valley.



used a set of 13 pipe traps (24 hour sets) placed in burrows to collect crayfish.

Results

Our collection resulted in the capture of three *Cambarus dubius* (Cat. 1492). All specimens were retained and cataloged into TWRA's crayfish collection in Morristown. This represents the first documentation of this species at this location within the watershed.

Discussion

The collection and identification of burrowing crayfish is a relatively new area of investigation that is much needed throughout the state. This collection will aid in completing the distribution for this species and identifying this wetland as a habitat that should be protected from development.

Management Recommendations

1. Any action that would preserve the integrity of this wetland would be of benefit for sustaining this population of crayfish.

Pearson Cave Tract

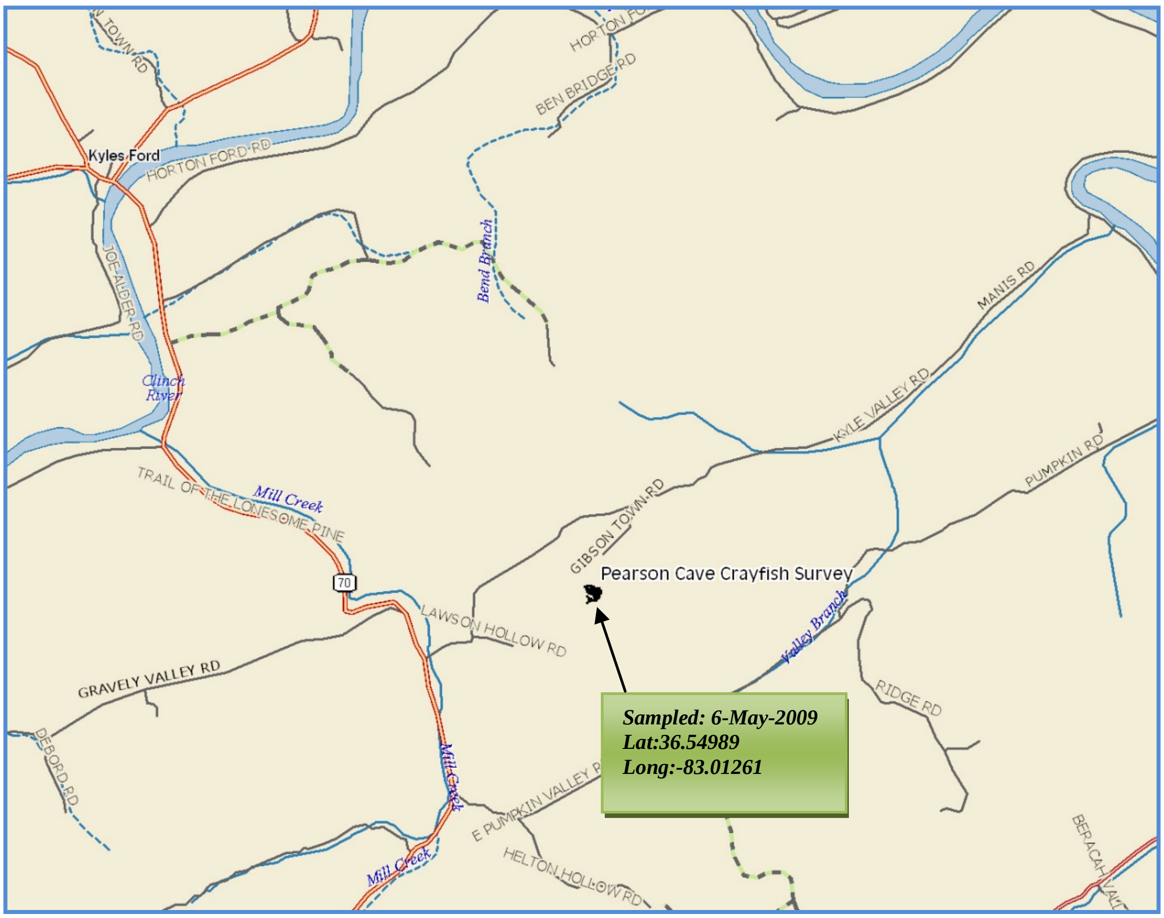
Introduction

The stream survey unit in Region 4 has had a long standing interest in crayfish distribution not only within the region but throughout the state. As a result, documentation of species occurrence and distribution has been made for many areas within the region and to a lesser extent statewide. During 2009, we specifically designed a limited number of crayfish surveys to evaluate the composition of species that were considered primary burrowers within the Clinch and Powell river watersheds.

Study Area and Methods

The Pearson Cave tract was acquired by TWRA in 2009 in order to protect unique habitat features found on the property. The property is located along Kyle Valley Road in Hawkins County (Figure 36). Our survey site was located along an unnamed spring that originated on the property that had associated wetland habitat. We used eight pipe traps (24 hour sets) placed in burrows to collect crayfish.

Figure 36. Sample site location for the crayfish survey conducted on the Pearson Cave Tract.



Results

Our collection resulted in the capture of three *Cambarus dubius* (Cat. 1493). All specimens were retained and cataloged into TWRA's crayfish

collection in Morristown. This represents the first documentation of this species at this location within the watershed.

Discussion

The collection and identification of burrowing crayfish is a relatively new area of investigation that is much needed throughout the state. This collection will aid in completing the distribution for this species and identifying this wetland as a habitat that should be protected from development.

Management Recommendations

1. Any action that would preserve the integrity of this wetland would be of benefit for sustaining this population of crayfish.

Kyles Ford WMA

Introduction

The stream survey unit in Region 4 has had a long standing interest in crayfish distribution not only within the region but throughout the state. As a result, documentation of species occurrence and distribution has been made for many areas within the region and to a lesser extent statewide. During 2009, we specifically designed a limited number of crayfish surveys to evaluate the composition of species that were considered primary burrowers within the Clinch and Powell river watersheds.

Study Area and Methods

Kyles Ford WMA is a 1,000 acre parcel located in Hancock and Hawkins counties that was acquired by TWRA in order to protect unique habitat features found on the property. The wetland area we surveyed was adjacent to a small tributary originating from Testerman Hollow along Hwy 70 (Figure 37). We used eight pipe traps (24 hour sets) placed in burrows to collect crayfish.

Figure 37. Sample site location for the crayfish survey conducted on Kyles Ford WMA.

Results

Our collection resulted in the capture of one *Cambarus dubius* (Cat. 1494). All specimens were retained and cataloged into TWRA's crayfish collection in
Morristown. This represents the first documentation of this species at this location within the watershed.

Discussion

The collection and identification of burrowing crayfish is a relatively new area of investigation that is much needed throughout the state. This collection will aid in completing the distribution for this species and identifying this wetland as a habitat that should be protected from development.

Management Recommendations

1. Any action that would preserve the integrity of this wetland would be of benefit for sustaining this population of crayfish.

Gap Creek Wetland

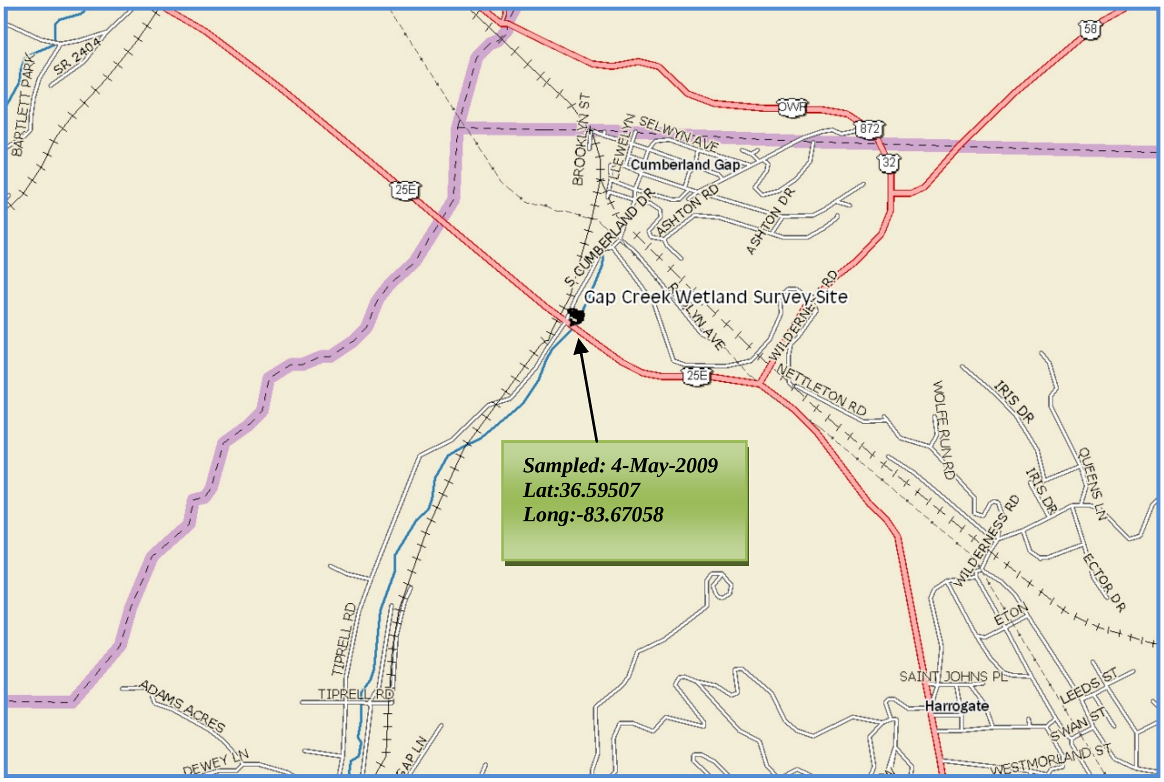
Introduction

The stream survey unit in Region 4 has had a long standing interest in crayfish distribution not only within the region but throughout the state. As a result, documentation of species occurrence and distribution has been made for many areas within the region and to a lesser extent statewide. During 2009, we specifically designed a limited number of crayfish surveys to evaluate the composition of species that were considered primary burrowers within the Clinch and Powell river watersheds. This was the only survey conducted in the Powell River watershed.

Study Area and Methods

Gap Creek originates in the town of Cumberland Gap just outside of Harrogate in Claiborne County. The stream flows in a southwesterly direction before joining the Powell River near the community of Arthur. The wetland area we surveyed was adjacent to Gap Creek along Tiprell Road (Figure 38). We used five pipe traps (24 hour sets) placed in burrows to collect crayfish.

Figure 38. Sample site location for the crayfish survey conducted along Gap Creek.



Results

Our collection resulted in the capture of three *Cambarus dubius* (Cat. 1495). All specimens were retained and cataloged into TWRA's crayfish collection in
Morristown. This represents the first documentation of this species at this location within the watershed.

Discussion

The collection and identification of burrowing crayfish is a relatively new area of investigation that is much needed throughout the state. This collection will aid in completing the distribution for this species and identifying this wetland as a habitat that should be protected from development.

Management Recommendations

1. Any action that would preserve the integrity of this wetland would be of benefit for sustaining this population of crayfish.

East Branch Bear Creek

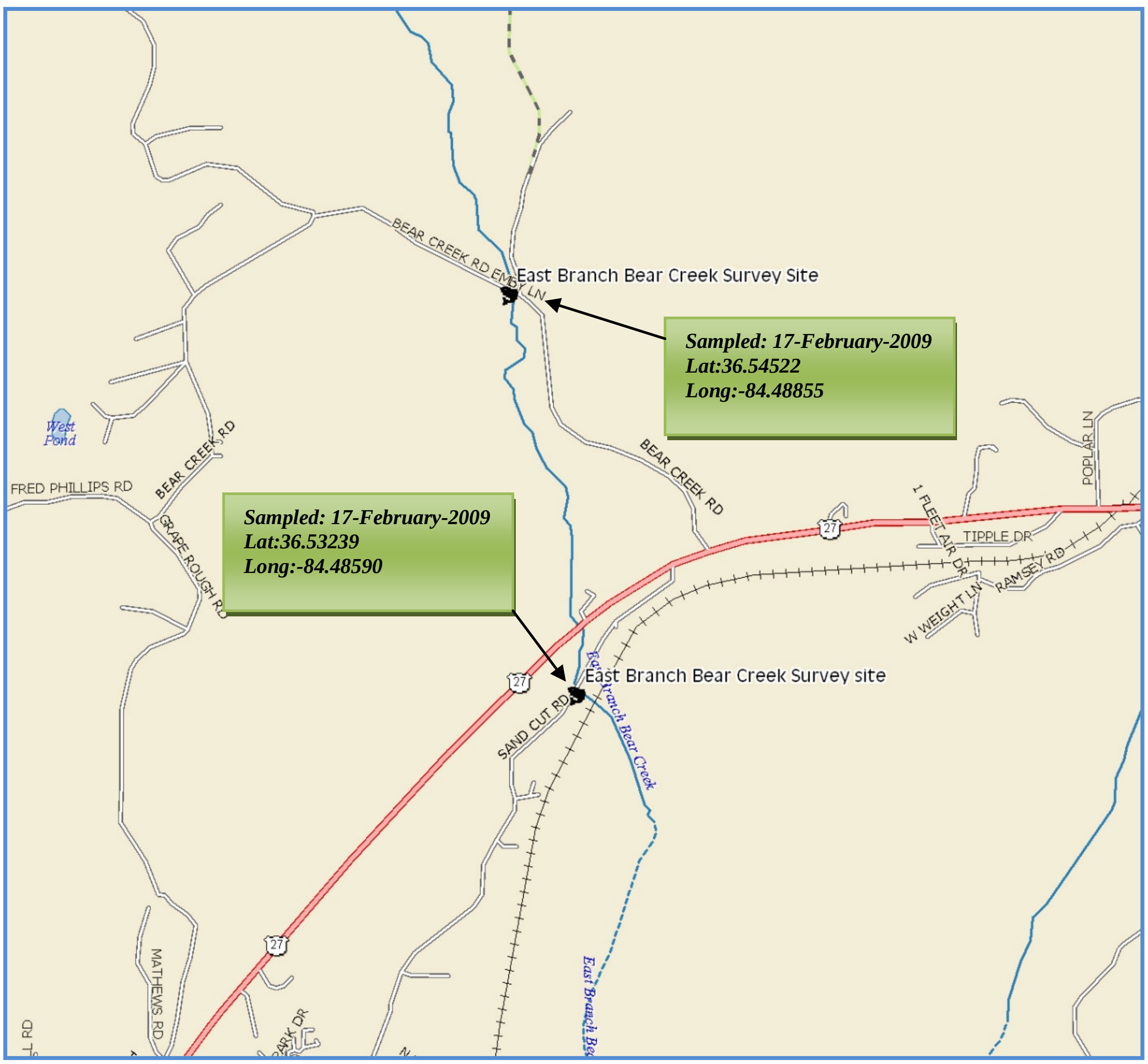
Introduction

With increasing regularity, TWRA is asked to assist other state agencies regarding aquatic resource alterations and potential effects on aquatic wildlife. We were asked by TDOT and TWRA Environmental Services Division to survey this stream as part of a highway relocation project. The state listed Big South Fork crayfish *Cambarus bourchardi* is endemic to this area and it was a concern that this species might inhabit this stream.

Study Area and Methods

Our survey sites were located at the road crossing on Sand Cut Road just upstream of the Hwy. 27 crossing and at the bridge crossing on Bear Creek Road (Figure 39). Our survey extended from an area just above the railroad crossing downstream to Hwy. 27 and the area immediately upstream from the bridge on Bear Creek Road. We collected crayfish by turning rocks and kick netting during a combined 7.5 hour effort. Leaf packs and woody debri in the stream channel were also searched.

Figure 39. Sample site locations for the survey conducted in East Branch Bear Creek.



Results

The best habitat we encountered at either location was the stream segment above the railroad bridge. The area downstream of this was being

logged and beaver dams inundated a portion of the stream below Hwy. 27. There was heavy siltation at the sampling station along Bear Creek Road and leaching from abandoned strip mines was still influencing the stream. All of the adult crayfish collected came from the area above the railroad crossing and the site along Bear Creek Road. Only juvenile crayfish were collected in the section of stream between Sand Cut Road and Hwy. 27. A total of 20 crayfish

were collected from both sites, which at the time were determined to be *Cambarus crinipes*. However, upon further lab analysis the crayfish collected from this stream appear to be an undescribed form. Specimens were sent to Dr. Guenter Schuster at Eastern Kentucky University where he examined them an essentially came to the same conclusion that the crayfish from this stream could be a new species.

Discussion

Based on our findings, the most critical area of the stream identified for protection is the reach upstream of the railroad bridge. This area appeared to relatively undisturbed and provided the best habitat for aquatic organisms that we

observed during our survey. The proposed highway route would not infringe on this area and based on our findings probably would not have any more detrimental effect on the stream than the present and historical activities are currently having. We recommended that the proposed highway routes that were downstream of the railroad crossing be considered for implementation as these would protect the stream reach we felt contained optimal habitat and would minimize impacts to the crayfish population.

Management Recommendations

1. Consider highway routing alternatives that are located downstream of the railroad bridge crossing.

2. Pursue the determination of the crayfish species collected from the stream.

Summary

During 2009, we collected 30 fish, nine benthic, and six crayfish samples. These included samples from Little River, Holston River, French Broad River, Nolichucky River, and Pigeon River. Additionally, three streams and five wetland areas were also surveyed. Cooperative Index of Biotic Integrity surveys were conducted in Little River and the Pigeon River. Overall, CPUE estimates for black bass and rock bass looked relatively good despite several years of low water. Both the Holston and French Broad rivers had stable or increasing trends in smallmouth bass CPUE. Overall, rock bass CPUE increase in both rivers with the exception of the Holston below Cherokee Reservoir which declined to a value of 32/hour. This was the lowest catch observed since sampling was initiated in 2000.

Our muskellunge surveys during 2009 were not fruitful; however, we are determined to keep an effort going to characterize the population currently residing in the Nolichucky River. Muskellunge stocking within the region was the highest since it was initiated in 1988. Approximately 9,144 fingerling musky were released in the French Broad and Nolichucky rivers during 2009.

The IBI surveys for Little River and the Pigeon River either remained the same or showed improvement when compared to the 2008 values. In Little River, the Townsend site improved slightly whereas the Coulters Bridge site remained unchanged from the previous year. In both situations, the fish communities received scores of excellent. The Pigeon River exhibited increases at both sites in 2009, increasing four points at the Tannery Island site and two points at the Denton site. In Little River, the index at the Coulters Bridge site remained the same as the 2008 value 58 “excellent”. The score for the Townsend site increased two points from the 2008 value to 58 receiving a score of excellent. Fish reintroductions continued on the Pigeon River with many of the introduced species collected in the 2009 IBI samples. Benthic macroinvertebrate trends in Little River and the Pigeon River saw an upswing in 2009. In both rivers total taxa and EPT taxa richness increased substantially over the 2008 values. Biotic index values also increased as a result of the increased diversity and percentage of intolerant forms in the samples.

Our crayfish surveys proved to be successful in 2009. We documented the occurrence of the burrowing crayfish *Cambarus dubius* in five localities in the Clinch River and Powell River watersheds. The survey of East Branch Bear Creek resulted in the discovery of what has been preliminarily determined as an undescribed species of crayfish.

Over the past 16 years the stream survey unit has been conducting Index of Biotic Integrity surveys in various watersheds within the region. These have been done in response to requests made by TWRA personnel, cooperative effort requests, and general interest in determining the state of certain streams. Our compilation of these surveys has given us a reference database for many streams in the region that can be used for comparison purposes should we return

for a routine survey or responding to a water quality issue. Table 18 lists our results for various streams surveyed during this time period.

Table 18. Index of Biotic Integrity and Benthic Biotic Index scores for samples conducted between 1994 and 2009.

Water	Watershed	Year Surveyed	County	IBI Score	Benthic BI Score
Capuchin Creek	Cumberland River	1994	Campbell	44 (Fair)	3 (Fair/Good)
Trammel Branch	Cumberland River	1994	Campbell	36 (Poor/Fair)	3 (Fair/Good)
Hatfield Creek	Cumberland River	1994	Campbell	42 (Fair)	3 (Fair/Good)
Baird Creek	Cumberland River	1994	Campbell	38 (Poor/Fair)	3 (Fair/Good)
Clear Fork (Site 1)	Cumberland River	1994	Campbell	52 (Good)	3 (Fair/Good)
Clear Fork (Site 2)	Cumberland River	1994	Claiborne	40 (Fair)	N/A
Clear Fork (Site 3)	Cumberland River	1994	Claiborne	24 (Very Poor/Poor)	1 (Poor)
Elk Fork Creek	Clear Fork	1994	Campbell	40 (Fair)	2 (Fair)
Fall Branch	Clear Fork	1994	Campbell	28 (Poor)	1 (Poor)
Crooked Creek	Clear Fork	1994	Campbell	38 (Poor/Fair)	2 (Fair)
Burnt Pone Creek	Clear Fork	1994	Campbell	38 (Poor/Fair)	2 (Fair)
Whistle Creek	Clear Fork	1994	Campbell	38 (Poor/Fair)	2 (Fair)
Little Elk Creek	Clear Fork	1994	Campbell	40 (Fair)	2 (Fair)
Lick Fork	Clear Fork	1994	Campbell	38 (Poor/Fair)	2 (Fair)
Terry Creek	Clear Fork	1994	Campbell	48 (Good)	2 (Fair)
Crouches Creek	Clear Fork	1994	Campbell	28 (Poor)	1 (Poor)
Hickory Creek (Site 1)	Clear Fork	1994	Campbell	46 (Fair/Good)	3 (Fair/Good)
Hickory Creek (Site 2)	Clear Fork	1994	Campbell	48 (Good)	2 (Fair)
White Oak Creek	Clear Fork	1994	Campbell	30 (Poor)	2 (Fair)
No Business Branch	Clear Fork	1994	Campbell	30 (Poor)	3 (Fair/Good)
Laurel Fork	Clear Fork	1994	Campbell	52 (Good)	3 (Fair/Good)
Lick Creek	Clear Fork	1994	Campbell	44 (Fair)	3 (Fair/Good)
Davis Creek	Clear Fork	1994	Campbell	38 (Poor/Fair)	2 (Fair)
Rock Creek	Clear Fork	1994	Campbell	54 (Good/Excellent)	3 (Fair/Good)
Little Tackett Creek	Clear Fork	1994	Claiborne	28 (Poor)	3 (Fair/Good)
Unnamed tributary to Little Tackett Creek	Clear Fork	1994	Claiborne	0 (No Fish)	3 (Fair/Good)
Rose Creek	Clear Fork	1994	Campbell	36 (Poor/Fair)	2 (Fair)
Rock Creek	Clear Fork	1994	Claiborne	28 (Poor)	2 (Fair)
Tracy Branch	Clear Fork	1994	Claiborne	34 (Poor)	2 (Fair)
Little Yellow Creek (Site 1)	Cumberland River	1994	Claiborne	38 (Poor/Fair)	N/A
Little Yellow Creek (Site 2)	Cumberland River	1994	Claiborne	38 (Poor/Fair)	N/A
Little Yellow Creek (Site 3)	Cumberland River	1994	Claiborne	36 (Poor/Fair)	N/A
Hickory Creek	Clinch River	1995	Knox	46 (Fair/Good)	3 (Fair/Good)
White Creek	Clinch River	1995	Union	34 (Poor) (SC)	4 (Good)
Little Sycamore Creek	Clinch River	1995	Claiborne	40 (Fair)	4.5 (Good/Excel).
Big War Creek	Clinch River	1995	Hancock	50 (Good)	4 (Good)
North Fork Clinch River	Clinch River	1995	Hancock	46 (Fair/Good)	4 (Good)
Old Town Creek (Site 1)	Powell River	1995	Claiborne	40 (Fair)	4 (Good)
Old Town Creek (Site 2)	Powell River	1995	Claiborne	42 (Fair)	4 (Good)
Indian Creek	Powell River	1995	Claiborne	N/A	4 (Good)
Sweetwater Creek	Tennessee River	1995	Loudon	30 (Poor)	3 (Fair/Good)
Burnett Creek	French Broad River	1995	Knox	46 (Fair/Good)	3 (Fair/Good)
Jockey Creek	Nolichucky River	1995	Greene	34 (Poor)	3 (Fair/Good)
South Indian Creek (Sandy Bottoms)	Nolichucky River	1995	Unicoi	38 (Poor/Fair)	4 (Good)
South Indian Creek (Ernestville)	Nolichucky River	1995	Unicoi	44 (Fair)	4 (Good)
Spivey Creek	Nolichucky River	1995	Unicoi	54 (Good/Excellent)	4 (Good)
Little Flat Creek	Holston River	1995	Knox	42 (Fair)	3 (Fair/Good)
Beech Creek	Holston River	1995	Hawkins	48 (Good)	4 (Good)
Big Creek	Holston River	1995	Hawkins	46 (Fair/Good)	4 (Good)
Alexander Creek	Holston River	1995	Hawkins	34 (Poor)	4 (Good)
Thomas Creek	South Fork Holston River	1995	Sullivan	54 (Good/Excellent)	4 (Good)
Hinds Creek	Clinch River	1996	Anderson	36 (Poor/Fair)	3 (Fair/Good)
Cove Creek	Clinch River	1996	Campbell	28 (Poor)	3 (Fair/Good)
Titus Creek	Clinch River	1996	Campbell	42 (Fair)	3 (Fair/Good)
Cloyd Creek	Tennessee River	1996	Loudon	36 (Poor/Fair)	4 (Good)
Sinking Creek	Little Tennessee River	1996	Loudon	34 (Poor)	4 (Good)
Baker Creek	Little Tennessee River	1996	Loudon	26 (Very Poor/Poor)	3 (Fair/Good)
Little Baker Creek	Little Tennessee River	1996	Blount	38 (Poor/Fair)	4 (Good)
Ninemile Creek	Little Tennessee River	1996	Blount	24 (Very Poor/Poor)	4 (Good)
East Fork Little Pigeon River	French Broad River	1996	Sevier	36 (Poor/Fair)	3 (Fair/Good)
Dunn Creek	French Broad River	1996	Sevier	32 (Poor)	4 (Good)
Wilhite Creek	French Broad River	1996	Sevier	44 (Fair)	4 (Good)
Watauga River (above Watauga Res.)	Holston River	1996	Johnson	42 (Fair)	4 (Good)
Stony Fork	Big South Fork	1996	Campbell	38 (Poor/Fair)	4 (Good)

Table 18. Continued.

Water	Watershed	Year Surveyed	County	IBI Score	Benthic BI Score
Bullett Creek	Hiwassee River	1997	Monroe	50 (Good)	4.5 (Good/Excel.)
Canoe Branch	Powell River	1997	Claiborne	26 (V Poor/Poor) (SC)	4.7 (Excellent)
Town Creek	Tennessee River	1997	Loudon	34 (Poor)	2 (Fair)
Bat Creek	Little Tennessee River	1997	Monroe	30 (Poor)	1.5 (Poor/Fair)
Island Creek	Little Tennessee River	1997	Monroe	40 (Fair)	4 (Good)
Little Pigeon River	French Broad River	1997	Sevier	40 (Fair)	2 (Fair)
West Prong Little Pigeon River	French Broad River	1997	Sevier	46 (Fair/Good)	2 (Fair)
Flat Creek	French Broad River	1997	Sevier	30 (Poor)	3.8 (Good)
Clear Creek	French Broad River	1997	Jefferson	34 (Poor)	2.2 (Fair)
Richland Creek	Nolichucky River	1997	Greene	30 (Poor)	2.3 (Fair)
Middle Creek	Nolichucky River	1997	Greene	34 (Poor)	4 (Good)
Sinking Creek	Pigeon River	1997	Cocke	30 (Poor)	3.8 (Good)
Chestuee Creek	Hiwassee River	1998	Monroe	28 (Poor)	2.5 (Fair/Fair -Good)
Fourmile Creek	Powell River	1998	Hancock	36 (Poor/Fair)	4.5 (Good/Excel.)
Martin Creek	Powell River	1998	Hancock	50 (Good)	4 (Good)
Big Creek	Tellico River	1998	Monroe	46 (Fair/Good)	4 (Good)
Oven Creek	Nolichucky River	1998	Cocke	40 (Fair)	2.9 (Fair/Good)
Cherokee Creek	Nolichucky River	1998	Washington	36 (Poor/Fair)	2.8 (Fair/Good)
Bennetts Fork	Cumblerland River	2000	Claiborne	30 (Poor)	3.5 (Fair/Good)
Gulf Fork Big Creek	French Broad River	2001	Cocke	42 (Fair)	4.0 (Good)
Nolichucky River	French Broad River	2001	Unicoi	56 (Good/Excellent)	4.0 (Good)
North Fork Holston River	Holston River	2001	Hawkins	50 (Good)	4.5 (Good)
Stinking Creek	Cumberland River	2002	Campbell	42 (Fair)	4.5 (Good)
Straight Fork	Cumberland River	2002	Campbell	18 (Very Poor)	3.0 (Fair/Good)
Montgomery Fork	Cumberland River	2002	Campbell	48 (Good)	3.5 (Fair/Good)
Turkey Creek	Holston River	2003	Hamblen	34 (Poor)	1.5 (Poor)
Spring Creek	Holston River	2003	Hamblen	34 (Poor)	2.2 (Fair)
Cedar Creek	Holston River	2003	Hamblen	30 (Poor)	3.5 (Fair/Good)
Fall Creek	Holston River	2003	Hamblen	32 (Poor)	2.3 (Fair)
Holley Creek	Nolichucky River	2003	Greene	30 (Poor)	2.4 (Fair)
College Creek	Nolichucky River	2003	Greene	36 (Poor/Fair)	2.2 (Fair)
Kendrick Creek	South Fork Holston River	2004	Sullivan	34 (Poor)	3.8 (Fair/Good-Good)
Sinking Creek	South Fork Holston River	2004	Sullivan	32 (Poor)	3.8 (Fair/Good-Good)
Mud Creek	Nolichucky River	2004	Greene	46 (Fair/Good)	4.0 (Good)
New River (Site 1)	Big South Fork Cumberland River	2004	Anderson	30 (Poor)	4.2 (Good)
New River (Site 2)	Big South Fork Cumberland River	2004	Campbell	42 (Fair)	3.5 (Fair/Good)
Indian Fork	Big South Fork Cumberland River	2004	Anderson	41 (Fair)	3.8 (Fair/Good-Good)
Unnamed Tributary to Taylor Branch	Hiwassee River	2005	Bradley	48 (Good)	4.0 (Good)
Little River (Coulters Bridge)	Tennessee River	2005	Blount	54 (Good/Excellent)	-
Little River (Townsend)	Tennessee River	2005	Blount	48 (Good)	-
Williams Creek	Clinch River	2005	Grainger	42 (Fair)	4.3 (Good)
Beaver Creek (Site 1)	Holston River	2005	Jefferson	38 (Poor/Fair)	2.8 (Fair/Fair-Good)
Beaver Creek (Site 2)	Holston River	2005	Jefferson	30 (Poor)	3.2 (Fair/Good)
Doe Creek	Holston River	2005	Johnson	46 (Fair/Good)	4.0 (Good)
Gap Creek	Nolichucky River	2005	Greene	36 (Poor/Fair)	3.5 (Fair/Good)
Pigeon River (Tannery Island)	French Broad River	2005	Cocke	52 (Good)	2.8 (Fair/Fair-Good)
Pigeon River (Denton)	French Broad River	2005	Cocke	48 (Good)	3.8 (Fair-Good/Good)
Little River (Coulters Bridge)	Tennessee River	2006	Blount	58 (Excellent)	4.2 (Good)
Little River (Townsend)	Tennessee River	2006	Blount	58 (Excellent)	4.7 (Good-Excellent)
Pigeon River (Tannery Island)	French Broad River	2006	Cocke	48 (Good)	3.5 (Fair-Good)
Pigeon River (Denton)	French Broad River	2006	Cocke	50 (Good)	3.8 (Fair-Good/Good)
Pigeon River (Hwy. 73 Bridge)	French Broad River	2006	Cocke	-	3.8 (Fair-Good/Good)
Little River (Coulters Bridge)	Tennessee River	2007	Blount	54 (Good)	3.8 (Fair-Good/Good)
Little River (Townsend)	Tennessee River	2007	Blount	56 (Good/Excellent)	4.0 (Good)
Pigeon River (Tannery Island)	French Broad River	2007	Cocke	54 (Good)	3.7 (Fair-Good/Good)
Pigeon River (Denton)	French Broad River	2007	Cocke	54 (Good)	3.5 (Fair/Good)
Little River (Coulters Bridge)	Tennessee River	2008	Blount	58 (Excellent)	3.8 (Fair-Good/Good)
Little River (Townsend)	Tennessee River	2008	Blount	56 (Good/Excellent)	3.0 (Fair/Good)
Pigeon River (Tannery Island)	French Broad River	2008	Cocke	44 (Fair)	2.0 (Fair)
Pigeon River (Denton)	French Broad River	2008	Cocke	48 (Good)	3.0 (Fair/Good)
Little River (Coulters Bridge)	Tennessee River	2009	Blount	58 (Excellent)	4.3 (Good)
Little River (Townsend)	Tennessee River	2009	Blount	58 (Excellent)	4.5 (Good)
Pigeon River (Tannery Island)	French Broad River	2009	Cocke	48 (Good)	3.0 (Fair/Good) July
Pigeon River (Denton)	French Broad River	2009	Cocke	50 (Good)	3.0 (Fair/Good) July
Pigeon River (Waterville)	French Broad River	2009	Cocke	-	4.5 (Good) March
Pigeon River (Denton)	French Broad River	2009	Cocke	-	4.3 (Good) March
Pigeon River (Tannery Island)	French Broad River	2009	Cocke	-	4.0 (Good) March
Poplar Creek	Clinch River	2009	Anderson	30 (Poor)	3.7 (Fair/Good-Good)
Titus Creek	Clinch River	2009	Campbell	-	4.5 (Good)

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APPENDIX A

Common and scientific names of fish used in this report (Nelson et al. 2004)

Family	Common Name	Scientific Name
Acipenseridae	Lake sturgeon	*Acipenser fulvescens*
Atherinidae	Brook silverside	*Labidesthes sicculus*
Catostomidae	River carpsucker	*Carpiodes carpio*
	White sucker	*Catostomus commersonii*
	Northern hog sucker	*Hypentelium nigricans*
	Smallmouth buffalo	*Ictiobus bubalus*
	Black buffalo	*Ictiobus niger*
	Spotted sucker	*Minytrema melanops*
	Silver redhorse	*Moxostoma anisurum*
	Smallmouth redhorse	*Moxostoma breviceps*
	River redhorse	*Moxostoma carinatum*
	Black redhorse	*Moxostoma duquesneii*
	Golden redhorse	*Moxostoma erythrurum*
Centrachidae	Rock bass	*Ambloplites rupestris*
	Redbreast sunfish	*Lepomis auritus*
	Green sunfish	*Lepomis cyanellus*
	Warmouth	*Lepomis gulosus*
	Bluegill	*Lepomis macrochirus*
	Redear sunfish	*Lepomis microlophus*
	Smallmouth bass	*Micropterus dolomieu*
	Spotted bass	*Micropterus punctulatus*
	Largemouth bass	*Micropterus salmoides*
Clupeidae	Gizzard shad	*Dorosoma cepedianum*
	Threadfin shad	*Dorosoma pentenense*
Cottidae	Banded sculpin	*Cottus carolinae*
Cyprinidae	Central stoneroller	*Campostoma anomalum*
	Largescale stoneroller	*Campostoma oligolepis*
	Whitetail shiner	*Cyprinella galactura*
	Spotfin shiner	*Cyprinella spiloptera*
	Carp	*Cyprinus carpio*
	Spotfin chub	*Erimonax monachus*
	Blotched chub	*Erimystax insignis*
	Bigeye chub	*Hybopsis amblops*
	Striped shiner	*Luxilus chrysocephalus*
	Warpaint shiner	*Luxilus coccogenis*
	Mountain shiner	*Lythrurus lirus*
	Scarlet shiner	*Lythrurus fasciolaris*
	River chub	*Nocomis micropogon*
	Tennessee shiner	*Notropis leuciodus*
	Highland shiner	*Notropis micropteryx*
	Silver shiner	*Notropis photogenis*
	Telescope shiner	*Notropis telescopes*
	Mimic shiner	*Notropis vollucelus*
	Stargazing minnow	*Phenocobius uranops*
	Bluntnose minnow	*Pimephales notatus*
	Longnose dace	*Rhinichthys cataractae*
Esocidae	Muskellunge	*Esox masquinongy*

Fundulidae	Northern studfish	*Fundulus catenatus*
Ictaluridae	Yellow bullhead	*Ameiurus natalis*
	Channel catfish	*Ictalurus punctatus*
	Mountain madtom	*Noturus eleutherus*
	Flathead catfish	*Pylodictus olivaris*
Lepisosteidae	Longnose gar	*Lepisosteus osseus*
Percidae	Greenside darter	*Etheostoma blenniodes*
	Bluebreast darter	*Etheostoma camurum*
	Blueside darter	*Etheostoma jessiae*
	Stripetail darter	*Etheostoma kennocotti*
	Redline darter	*Etheostoma ruflineatum*
	Tennessee darter	*Etheostoma tennessense*
	Banded darter	*Etheostoma zonale*
	Tangerine darter	*Percina aurantiaca*
	Blotchside logperch	*Percina burtoni*
	Logperch	*Percina caprodes*
	Gilt darter	*Percina evides*
	Snail darter	*Percina tanasi*
	Sickle darter	*Percina williamsi*
	Walleye	*Sander vitreum*
Petromyzontidae	Chestnut lamprey	*Icthyomyzon castaneus*
	Mountain brook lamprey	*Icthyomyzon greeleyi*
	American brook lamprey	*Lampetra appendix*
Poeciliidae	Western mosquitofish	*Gambusia affinis*
Sciaenidae	Drum	*Aplodinotus grunniens*